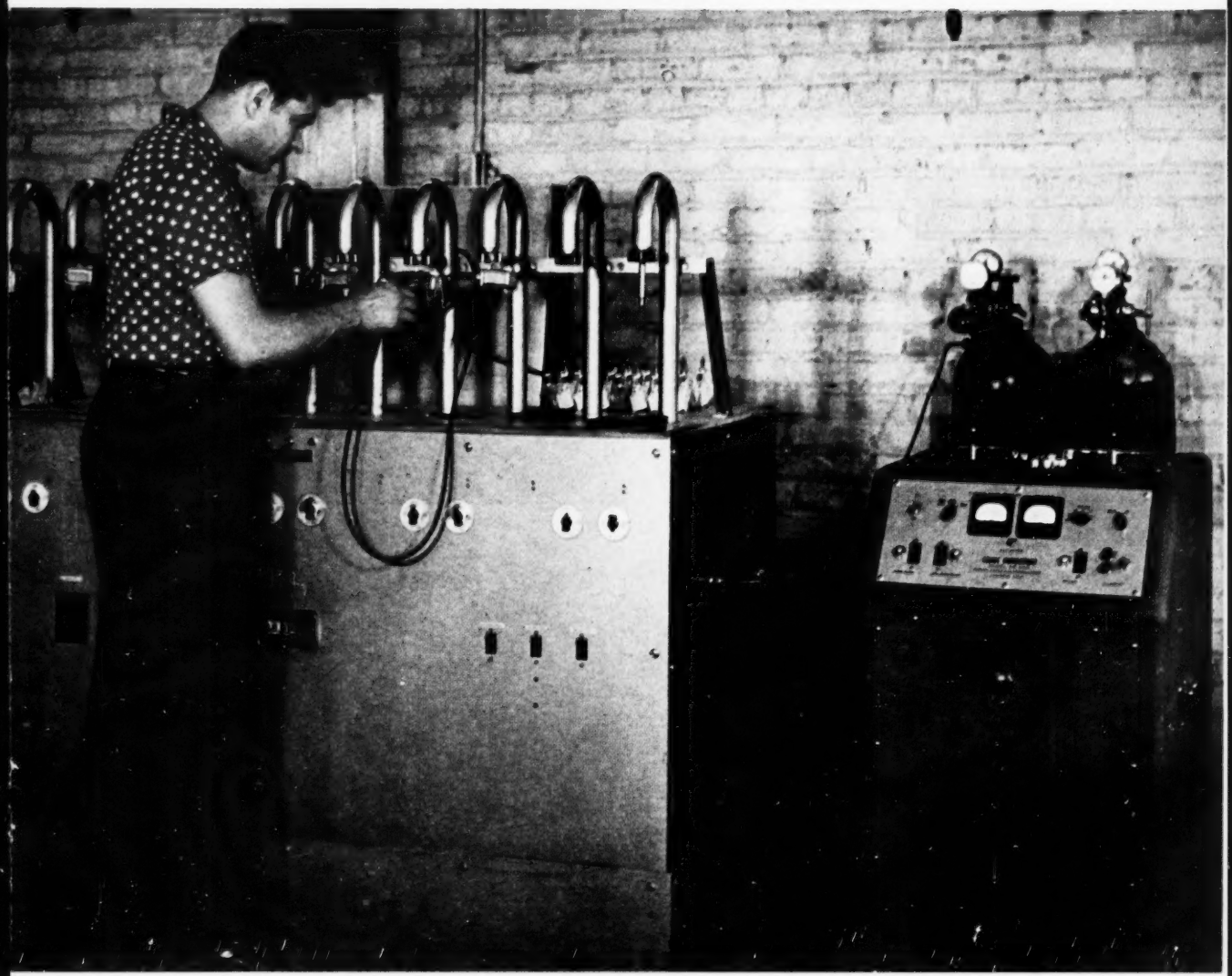
Instruments

THE MAGAZINE OF
MEASUREMENT · ANALYSIS · COMPUTING
INSPECTION · TESTING · CONTROL



Electro-Snap Switch & Mfg. Co. of Chicago uses a diffusion pump and 10-port manifold of Consolidated Vacuum Corp. and a Consolidated Engineering Corp. leak detector to evacuate, leak test, and back fill hermetically sealed limit switches for high-altitude use. *(See page 1074 for story.)*

Including the
JOURNAL OF THE INSTRUMENT SOCIETY OF AMERICA (Page 1091)
and the
JOURNAL OF THE SOUTHERN CALIFORNIA METER ASSOCIATION (Page 1211)

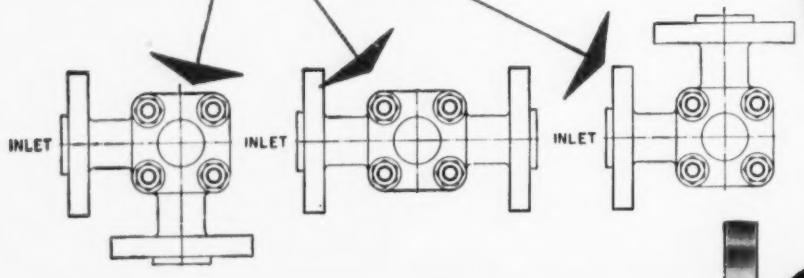
Vol. 26 No. 8
AUGUST • 1953

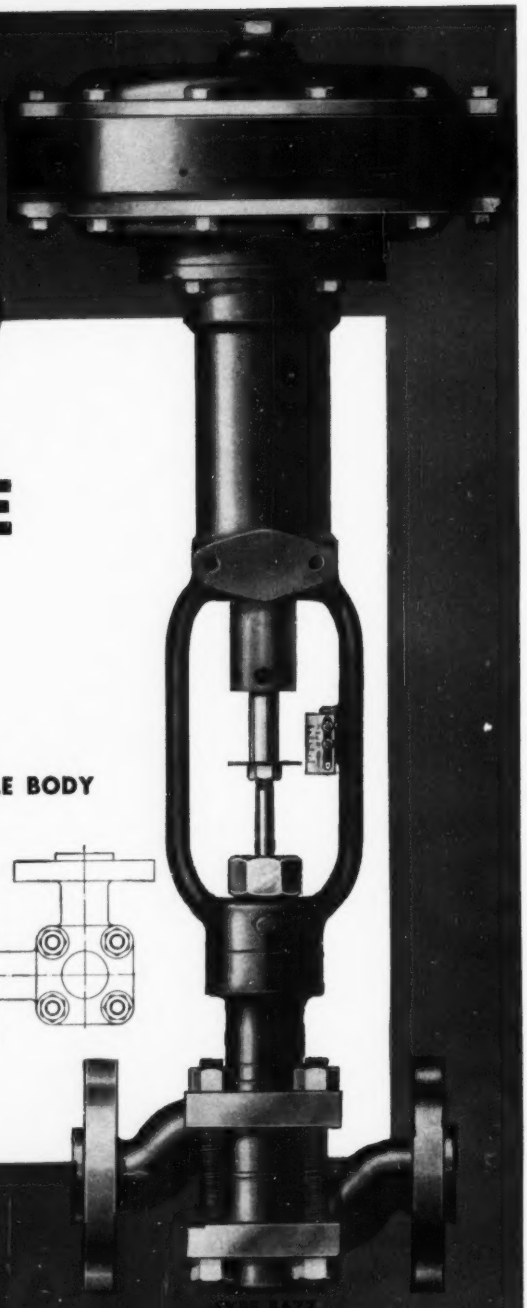
FISHER®

DIAPHRAGM MOTOR VALVE

WITH Z BODY

CAN BE EASILY CONVERTED TO OFFSET ANGLE BODY





TYPE 367Z
with REVERSE ACTING TOPWORKS

- Split flange construction with seat ring retained in center without threads.
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- Sizes ½", ¾", 1", 1½" and 2".
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For more information circle 1 on inquiry card.

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—and following every leader are those who would rather copy than create!

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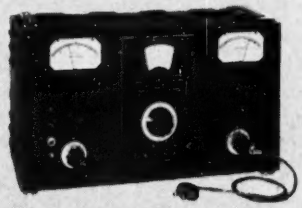
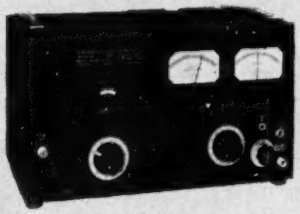
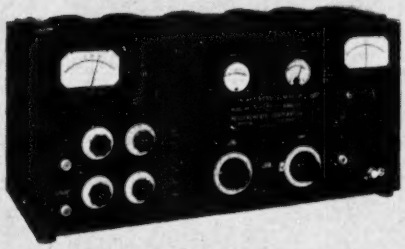
STANDARDS ARE ONLY AS RELIABLE AS THE REPUTATION OF THEIR MAKER



Model 65-B
STANDARD SIGNAL GENERATOR



Model 80
STANDARD SIGNAL GENERATOR



Model 84
STANDARD SIGNAL GENERATOR

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1939 MODEL 54 STANDARD SIGNAL GENERATOR—Frequency range of 100 Kc. to 20 Mc. The first commercial signal generator with built-in tuning motor.

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1940 MODEL 58 UHF RADIO NOISE & FIELD STRENGTH METER—With a frequency coverage from 15 Mc. to 150 Mc. This instrument filled a long wanted need for a field strength meter usable above 20 Mc.

MODEL 79-B PULSE GENERATOR—The first commercially-built pulse generator.

1941 MODEL 75 STANDARD SIGNAL GENERATOR—The first generator to meet the need for an instrument covering the I.F. and carrier ranges of high frequency receivers. Frequency range, 50 Mc. to 400 Mc.

1942 SPECIALIZED TEST EQUIPMENT FOR THE ARMED SERVICES.

1943 MODEL 84 STANDARD SIGNAL GENERATOR—A precision instrument in the frequency range from 300 Mc. to 1000 Mc. The first UHF signal generator to include a self-contained pulse modulator.

1944 MODEL 80 STANDARD SIGNAL GENERATOR—With an output metering system that was an innovation in the field of measuring equipment. This signal generator, with a frequency range of 2 Mc. to 400 Mc. replaced the Model 75 and has become a standard test instrument for many manufacturers of electronic equipment.

1945 MODEL 78-FM STANDARD SIGNAL GENERATOR—The first instrument to meet the demand for a moderately priced frequency modulated signal generator to cover the range of 86 Mc. to 108 Mc.

1946 MODEL 67 PEAK VOLTMETER—The first electronic peak voltmeter to be produced commercially. This new voltmeter overcame the limitations of copper oxide meters and electronic voltmeters of the r.m.s. type.

1947 MODEL 90 TELEVISION SIGNAL GENERATOR—The first commercial wide-band, wide-range standard signal generator ever developed to meet the most exacting standards required for high definition television use.

1948 MODEL 59 MEGACYCLE METER—The familiar grid-dip meter, but its new design, wide frequency coverage of 2.2 Mc. to 400 Mc. and many other important features make it the first commercial instrument of its type to be suitable for laboratory use.

1949 MODEL 82 STANDARD SIGNAL GENERATOR—Providing the extremely wide frequency coverage of 20 cycles to 50 megacycles. An improved mutual inductance type attenuator used in conjunction with the 80 Kc. to 50 Mc. oscillator is one of the many new features.

MODEL 112 U.H.F. OSCILLATOR—Designed for the many applications in ultra-high frequency engineering that require a signal source having a high degree of frequency accuracy and stability. Range, 300 Mc. to 1000 Mc.

1950 MODEL 111 CRYSTAL CALIBRATOR—A calibrator that not only provides a test signal of crystal-controlled frequency but also has a self-contained receiver of 2 microwatts sensitivity.

1951 MODEL 31 INTERMODULATION METER—With completely self-contained test signal generator, analyzer, voltmeter and power supply. Model 31 aids in obtaining peak performance from audio systems, AM and FM receivers and transmitters.

1952 MODEL 84 TV STANDARD SIGNAL GENERATOR—With a frequency range of 300-1000 Mc., this versatile new instrument is the first of its kind designed for the UHF television field.

For more information circle **2** on inquiry card.

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K&M

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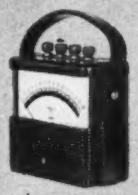

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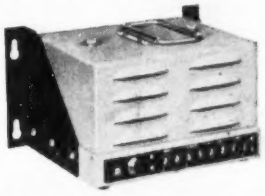
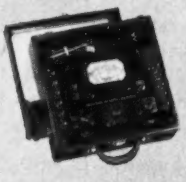
Model 697 Volt-Ohm-Milliammeter

One of a line of pocket-size meters, Model 697 combines a selection of a-c and d-c current, and resistance ranges. Ideal for maintenance testing and many inspection requirements.



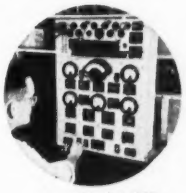
Model 1411 Inductronic D-C Amplifier

Stable amplifier provides high degree of resolution even at fractional loads. Reaches steady full scale deflection in a fraction of a second. Interchangeable plug-in range standards for either microamperes or millivolts.



Industrial Circuit Tester – Model 785

A multi-range, multi-purpose, ultra-sensitive analyzer, for laboratory and industrial checking of electrical and electronic circuits. Has 28 practical scale ranges; measures d-c and a-c voltage, d-c and a-c current, and resistance. Accessories available to extend ranges. Compact and portable; furnished in either oak or steel case.



Model 686
Electronic Tube Analyzer

Tests tubes under exact operating potentials. Accurately determines true mutual conductance of all tubes, in accordance with manufacturers' rated operating conditions, or under special operating conditions.

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A three-in-one instrument providing a self-contained Volt-Ohm-Milliammeter, a high impedance electronic D-C Volt-Ohmmeter, and a probe type Vacuum Tube Voltmeter for use to 300 megacycles. Exceptionally stable and accurate. Has specially designed extremely small RF and D-C probes.

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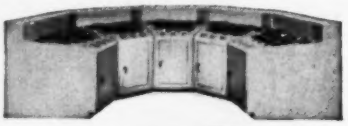
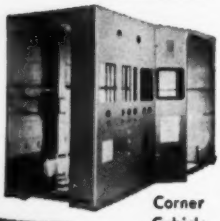


Benchboard Console



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Corner Cubicle Section

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Instruments
THE MAGAZINE OF MEASUREMENT
INSPECTION · TESTING · CONTROL

Vol. 26 August 1953 No. 8

SPECIAL FEATURE

Eighth Annual Instrument Exhibit—Descriptive List and Products 1203
Exhibit Floor Plan 1210

FEATURE ARTICLES

The Secrets in an Instrument Engineer's Notebook 1178
By Porter Hart and R. C. King
Use of Field Test Data for Control System Analysis 1180
By P. R. Hoyt and B. D. Stanton
Electrokinetic Transducers 1168
By E. V. Hardway, Jr.

SERIAL

Control of Chemical Processes 1182
By A. J. Young

THE MONTH'S NEW INSTRUMENTS

Process Control (and not otherwise classified) 1120
Flow-Rate and Volume 1124
Pressure, Load and Force 1128
Temperature 1132
Level 1134
Time and Count 1134
Computing 1137
For the Laboratory 1137
Inspection 1141
Testing 1142
For Instrument Shop 1150
Nucleonics 1154
Pneumatics 1155
Electrical Instruments 1156
Electrical-instrument Accessories 1161
Electromechanical Components 1168
Electrical and Electronic Components 1173
Valves 1176

INSTRUMENTS ON THE MARCH

400-Mc. Transistors 1230
Insecticide Safety 1230
Tunnel Safety 1230
X-ray Diffraction School 1230
Rubber Coating Control 1230
Environmental Testing 1230

MANUFACTURERS' NEW LITERATURE.... 1232

OTHER REGULAR FEATURES

Editorial: The Value of Instrumentation 1119
Calendar of Important Instrumentation Events 1249
Product Index 1251
Advertiser's Index 1253

JOURNAL of the
INSTRUMENT SOCIETY OF AMERICA....1191

Instrumentation's Place in the Managerial Organization 1194
By Robert H. Berg
Tentative Technical Program for the Eighth National ISA Conference and Exhibit 1200

JOURNAL of the
SOUTHERN CALIFORNIA METER ASSOCIATION

Oxygen Measurement 1211
By Owen K. Steffern

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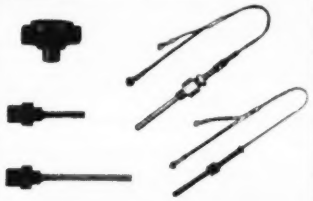
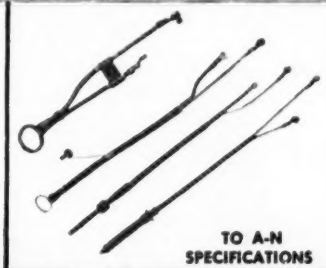


A-N, FREE-AIR, STUFFING-GLAND AND CYLINDER-HEAD BAYONET TYPES



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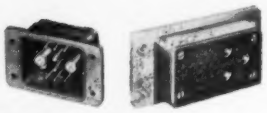
K & RK Designed for uses in aircraft, this versatile lightweight plug is widely used on a great variety of instruments and electronic equipment. Special acme coupling nut connection and disconnection. 8 contact sizes accommodate 16, 14, 10, 8, 6, 4, 2 and 0 AWG. Maximum 200a. 8 shell diameters. 204 insert variations. KH Series, hermetically sealed Type K, also available. Write for "K" Bulletin.

GS (AN) Designed for applications demanding hermetic sealing under high pressures in a temperature range from minus 300F to plus 600F. 2 basic shell designs. NEF threaded coupling nut. Steel shells and steel contacts. Mate with AN Series. See "AN" Bulletin or "GS" Bulletin.

XL For audio equipment and general electronic uses: 3 and 4 contact layouts, 10 and 15a; 17 shell designs; zinc and steel plug shells. Ask for "XL" Bulletin.



DPB–DPD For rack-and-panel installations, instrument panels and for any plug-in sub-assembly where both halves of the connector are rigidly mounted, or where one half is rigidly mounted and the other half cord mounted. 78 max. contacts, 200a maximum. Ask for "DP" Bulletin.

D SERIES SUB-MINIATURE PLUGS
Designed to meet the miniaturization program. Used both as rack-and-panel disconnect and cord connectors for hand portable radio equipment, audio circuitry and related applications. Keystone shaped. 15 to 50 gold-plated contacts. DH hermetically sealed also available. See "D" Bulletin.

U SERIES SUB-MINIATURE PLUGS
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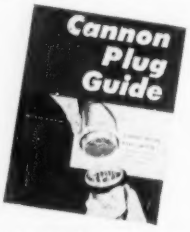

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COVER STORY

"Model-H" hermetically sealed limit switches of Electro-Snap Co., Chicago, control flaps, doors, wheels, etc., on aircraft. The switches are evacuated to 0.01 micron pressure, first by a 2-stage mechanical pump, then by a CVC diffusion pump. When switches reach 0.01 micron, the helium probe of the CEC leak detector is passed over each unit. Each switch passing the leak test is back filled with dry nitrogen. Tubulation is then crimped, cut off, and soldered.

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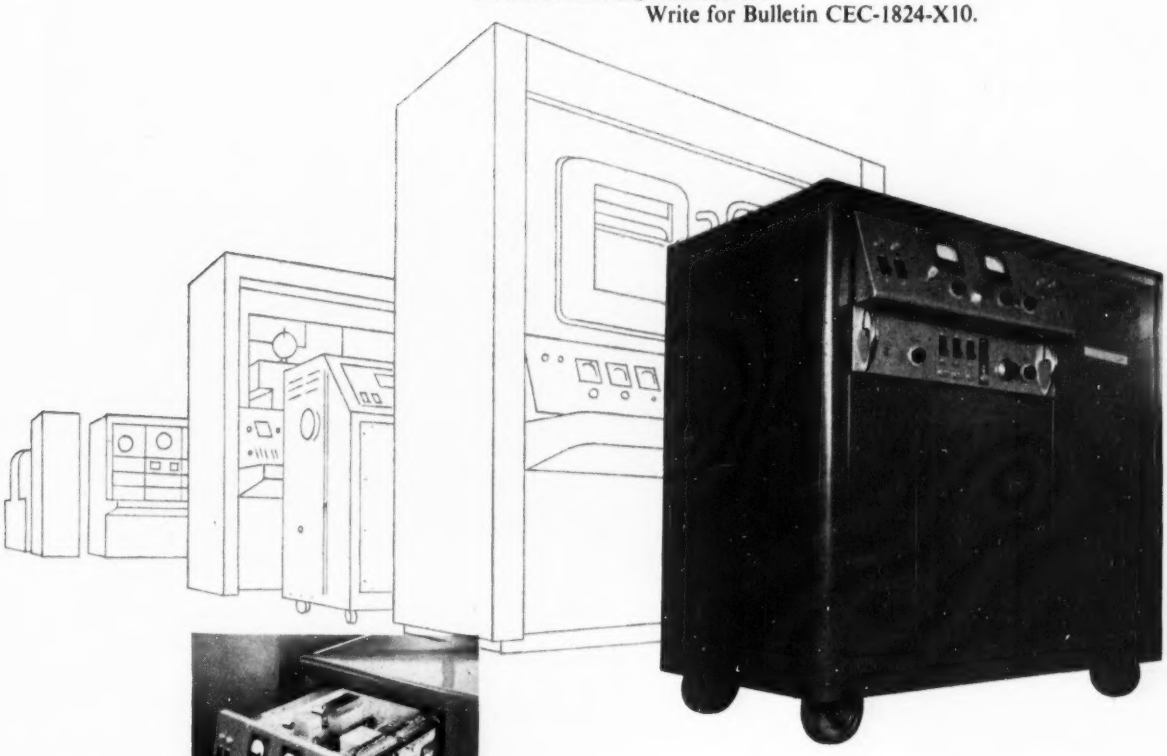
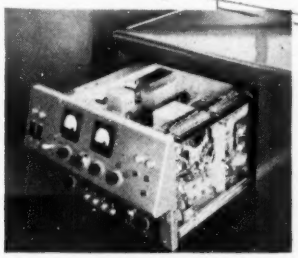
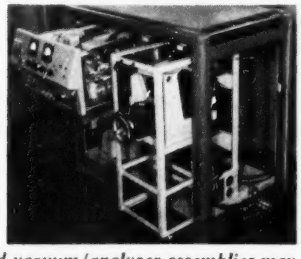
Write for Bulletin CEC-1824-X10.





All components are accessible: either by removing side panels or by pull-out chassis containing circuits and controls.



Electronic and vacuum/analyzer assemblies may be removed intact and operated independently.

Model 21-610 Mass Spectrometer

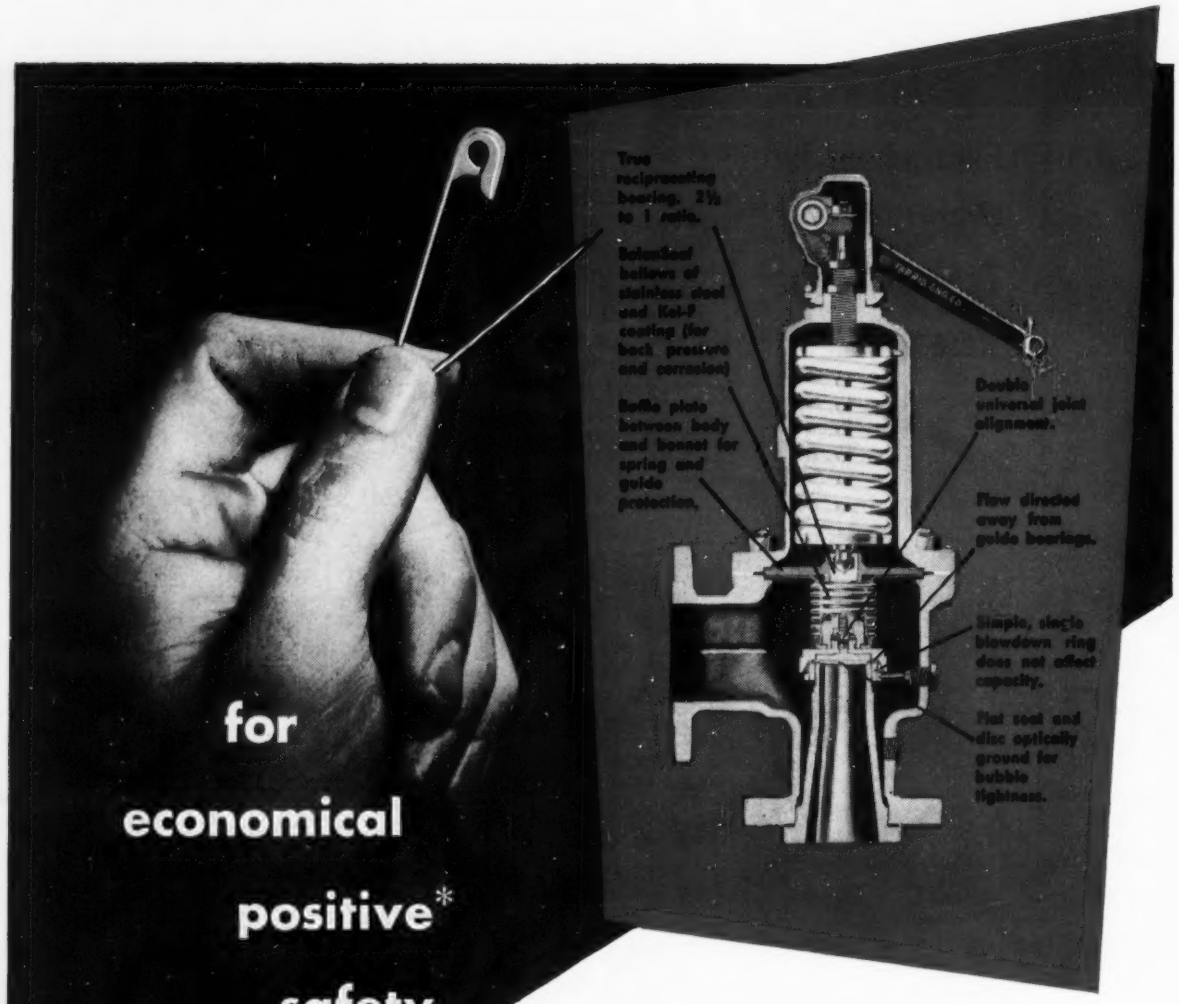
Consolidated Engineering
CORPORATION

300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.,** *a subsidiary with offices in: Pasadena, New York, Chicago, Washington, D. C., Philadelphia, Dallas.*

analytical instruments for science and industry

For more information circle 8 on inquiry card.


True reciprocating bearing, 2½ to 1 ratio.
Double universal joint alignment.
Baffle plate between body and bonnet for spring and guide protection.
Flow directed away from guide bearings.
Simple, single blowdown ring does not affect capacity.
Flat seat and disc optically ground for bubble tightness.

for economical positive* safety

BalanSeal and FarriSeal Safety-Relief Valves

(Pat'd & Pat. Pending)

Corrosion and varying back pressure—the two dangerous enemies of positive safety-relief valve operation—are stopped cold by the ingenious construction of Farris valves. Critical working parts are isolated from the lading fluid so that they can't stick, plug or corrode and the special bellows construction nullifies the effect of back-pressure surge. You get positive protection, under all operating conditions. Manufacturing economies offer realistic pricing—and the design permits the use of much smaller discharge piping, at an important saving. So for safety and economy, specify FarriSeal or BalanSeal safety-relief valves. You're never stuck, because they never stick!

Technical manual, 51B, a treatment on Back Pressure Piping and Surge characteristics and 76-page catalog is yours for the asking.

*ASME-N.B. APPROVED
(Certified for Capacity)

Farris

ENGINEERING CORPORATION

610 Commercial Avenue

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● FARRIS HYDROSEAL CORPORATION ● FARRIS PICKERING CORPORATION

For more information circle 9 on inquiry card. Circle 10 on inquiry card. →

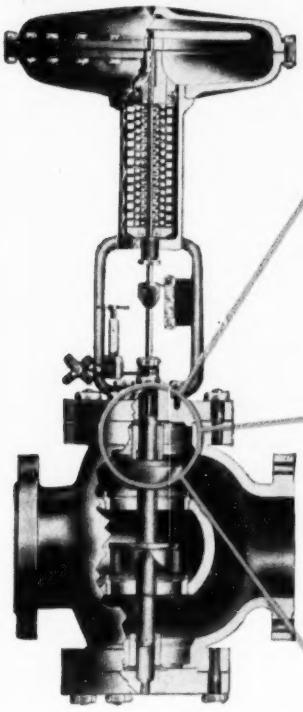
Have a preference... a special application?

There's A Standard Teflon Stuffing Box

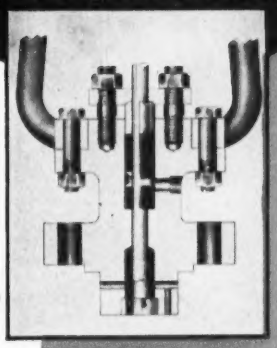
The use of Teflon in Climax Controls stuffing boxes is standard procedure with BS&B. There's a Climax Teflon stuffing box to meet any preference. Here, we show three of them as applied to Climax Diaphragm Control Valve Type 86. BS&B stresses correct stuffing box design because design has such a great effect on hysteresis. Any friction in the valve may result in improper operation and unsatisfactory service. To further overcome the threat of friction, the lower stems in all Climax Controls of this type are super polished.

Teflon resists almost all known corrosive fluids. It's self lubricating and means less friction. Spring loaded Teflon reduces maintenance which might normally result from packing nut being applied too tightly.

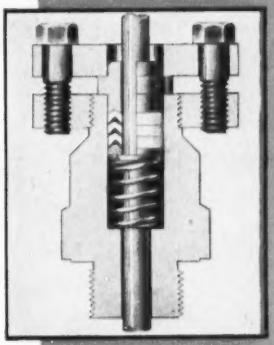
for the BS&B Climax Controls needed in your processing



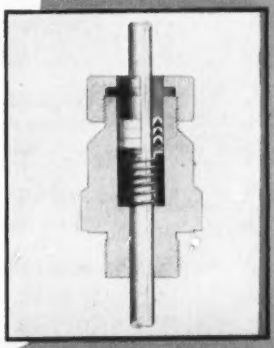
Teflon or Standard bolt stuffing box. *The top works or yoke of the valve is removable without disturbing the stuffing box. This stuffing box is applicable to Climax Controls, Types 86, 73, 1286, 15, 115, and 1486.*



Bolt-down type, spring loaded Teflon *using CVU Ring. Available for, or present standard stuffing box can be converted to, the following Climax Controls, Types 86, 73, 1286, 1486, 125, 120, 128, and 58.*



Standard Packing Nut stuffing box. *Screwed down packing nut design assures minimum frictional lag and a minimum of maintenance. Features the dependable CVU Teflon Ring. Can easily convert old style valves using standard stuffing box to Teflon packed.*



The type of stuffing box you require depends on . . . (1) The fluid being handled (2) Individual maintenance problems. The interchangeability of Climax Controls stuffing boxes is highly important to both old and new users. Teflon stuffing boxes are standard with Climax... or conventional type stuffing boxes may be specified or interchanged with Teflon stuffing boxes in the field with a minimum of time and effort. Tell us what fluids you're handling and what your problems are... then let us make a recommendation—Write...

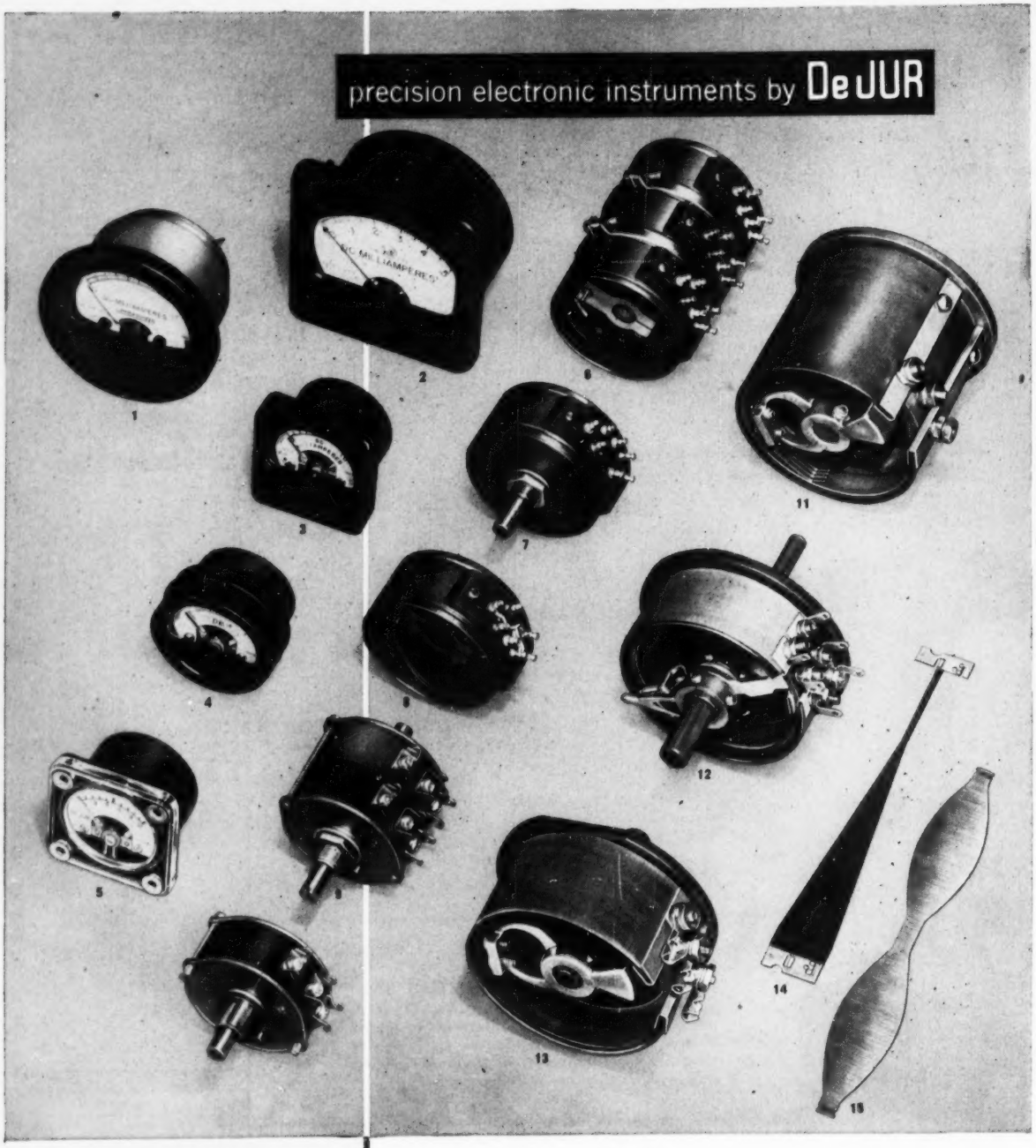
See our exhibit at the Eighth National Instrument Exhibit September 21 to 25, Sherman Hotel, Chicago, Booths 148 to 150.

CLIMAX BS&B CONTROLS OUR 50TH YEAR

BLACK, SIVALLS & BRYSON, INC.

CLIMAX CONTROLS DIVISION, DEPT. 4-V8

7500 East 12th Street Kansas City 26, Missouri



PANEL INSTRUMENTS

1. 2½" Ruggedized Meter. Meets MIL-M-10304. Model R210
2. 3½" A.S.A. Meter meets MIL-M-6A. Model S312
3. 1½" Meter. Conserves space. Built to SC-73-3. Model 112
4. 1½" Meter. Metal Case. Single Hole Mounting. Model 120
5. 1½" Ruggedized Meter. Meets MIL-10304. Model R112

PRECISION POTENTIOMETERS

6. Multiple ganging and external phasing 2" Diameter Model C200
7. Single hole mounting Model C200
8. Single Sine-Cosine Model C200
9. Dual Unit Model L402
10. 1-11/16" Diameter Center tapped Model L400
11. 3" Diameter 11 watt JAN-R-19 Const. Model 275
12. Dual Concentric Model 282
13. 3" Diameter 8 watt JAN-R-19 Const. Model 260
14. Non-Linear Card C200
15. Sine-Cosine Card C200

Actual performance records prove that these DeJUR components withstand adverse conditions of vibration, heat and moisture. Each is engineered and manufactured to meet rigid government requirements. In addition to its wide variety of stock instruments, DeJUR offers top-flight laboratory, engineering and manufacturing facilities for production of these precision units adapted to your specifications. Inquiries are invited.

Write for more detailed information on any of the products shown on this page to Dept. IP-8

DeJUR·AMSCO CORPORATION

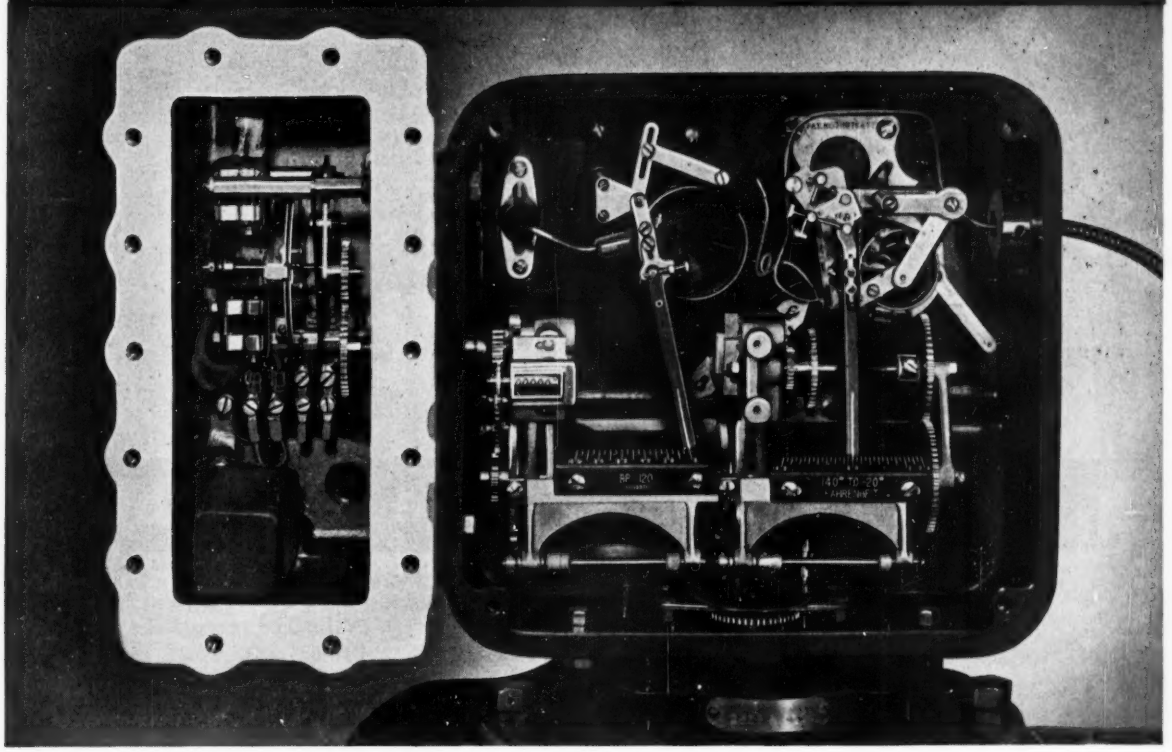
45-01 NORTHERN BOULEVARD, LONG ISLAND CITY 1, N. Y.

MANUFACTURERS OF SCIENTIFIC PRECISION EQUIPMENT FOR OVER 30 YEARS

For more information circle 11 on inquiry card.

NEW AMERICAN® TELECOUNTERS

for base volume indexes



Now you can read base volume indexes at any remote location

American Telecounters accurately transmit Base Volume Index indications of gas quantities, computed to base temperature and base pressure conditions, to any convenient reading station. Remote indications are read from a compact reset-type counter which installs anywhere. The counter is actuated by electrical impulses received from the transmitter housed in the explosion-proof case on the side of the Base Volume Index.

- **Reset-Type Counter only 1⅝"x 4"**
- **Explosion-Proof Transmitter Case**
- **Adapts to Large Capacity Ironcase Meters**
- **Reliable Transmission At All Times — Leased Wire, Private Wire Or Radio**
- **Power Pack Operates from Commercial 110 Volt, 60 Cycle, Single Phase Power Supply**

Be sure to visit Booth 167-8 • Eighth Annual Instrument Exhibit • Sherman Hotel, Chicago — Sept. 21-25

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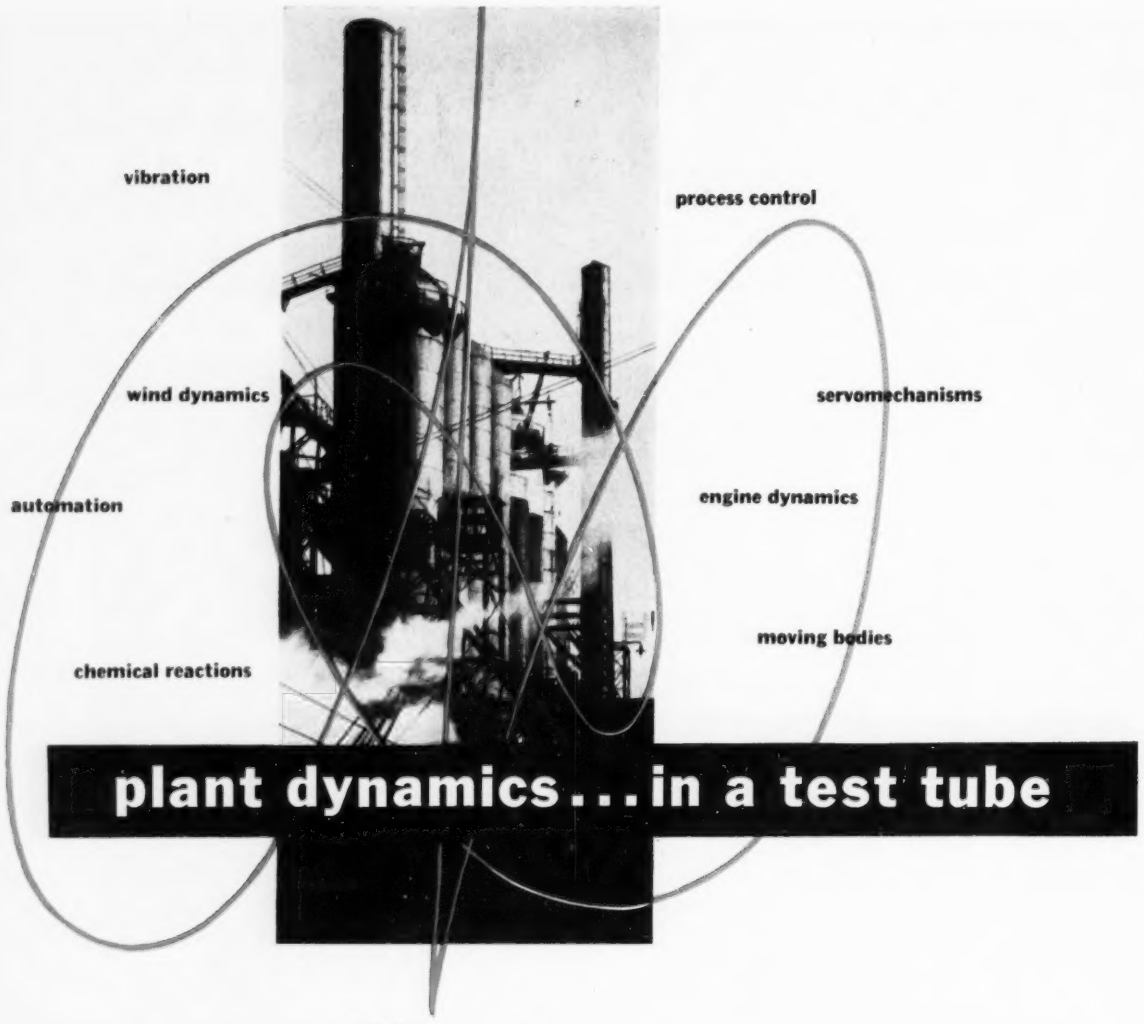
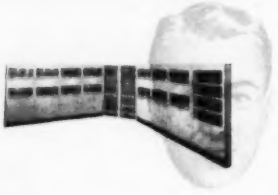
AMERICAN METER CO

AMERICAN® METER COMPANY
INCORPORATED ESTABLISHED 1836

For more information circle 12 on inquiry card.



plant dynamics . . . in a test tube



ANALOG STUDIES BY ASKANIA

Put your plant in a test tube. An analog study is a direct and inexpensive way to study the dynamics of plant processes.

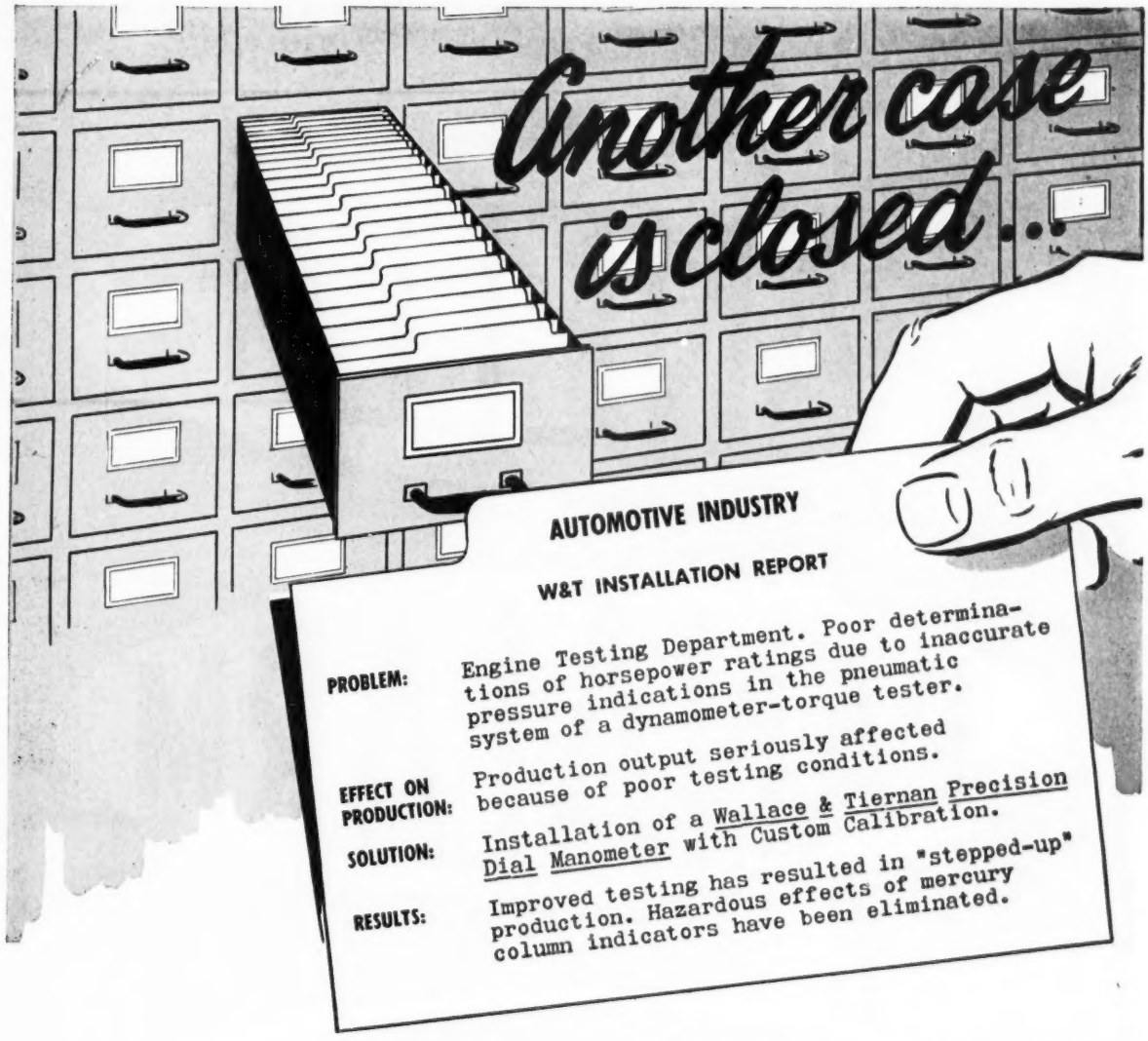
Askania analog computer service is a tool for you to use. Like a slide rule, it speeds your work. And it can extend your range far beyond the scope of manual computation. Results are presented graphically and numerically, with engineering accuracy.

This service is yours on a consulting basis, or as part of an Askania instrumentation and control project.

Write for Bulletin 153

ASKANIA REGULATOR COMPANY
262 E. Ontario Street, Chicago, Illinois
Subsidiary of General Precision Equipment Corp.

For more information circle 13 on inquiry card.


another case is closed...
AUTOMOTIVE INDUSTRY
W&T INSTALLATION REPORT
PROBLEM: Engine Testing Department. Poor determinations of horsepower ratings due to inaccurate pressure indications in the pneumatic system of a dynamometer-torque tester.
EFFECT ON PRODUCTION: Production output seriously affected because of poor testing conditions.
SOLUTION: Installation of a Wallace & Tiernan Precision Dial Manometer with Custom Calibration.
RESULTS: Improved testing has resulted in "stepped-up" production. Hazardous effects of mercury column indicators have been eliminated.

...Thanks to a W&T Precision Instrument

W&T Precision Dial Manometer

FEATURES:

Full protection against overpressure

Custom calibrated scales in units of force or torque

Two revolution indicator provides scale 45 in. long with only an 8½ in. diameter dial.

Sensitivity one part in 10,000; accuracy one part in 1000.

If you have a problem in the measurement or control of pressure, write today for additional information.

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ELECTRICAL MECHANISMS AND PRECISION INSTRUMENTS

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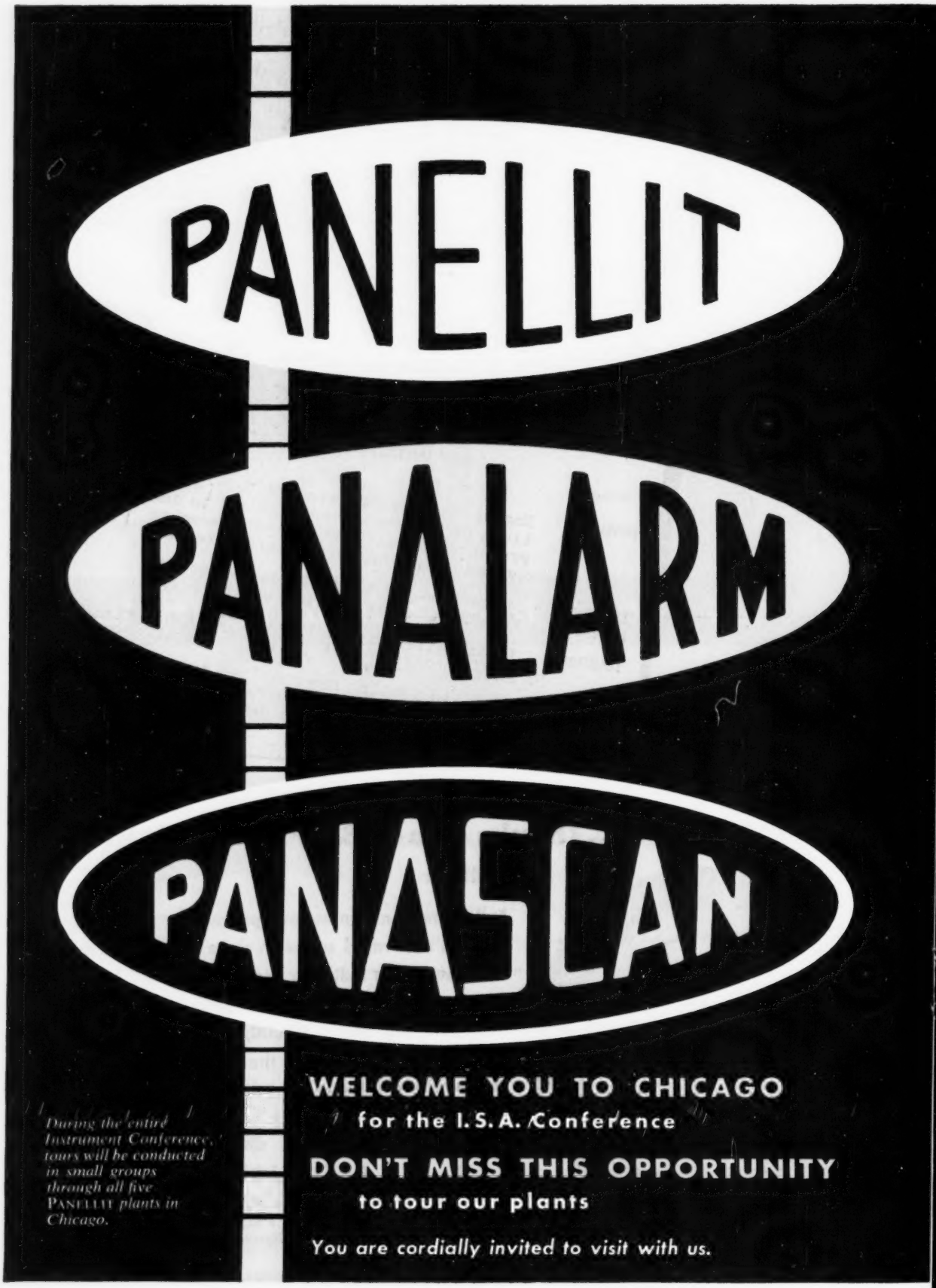
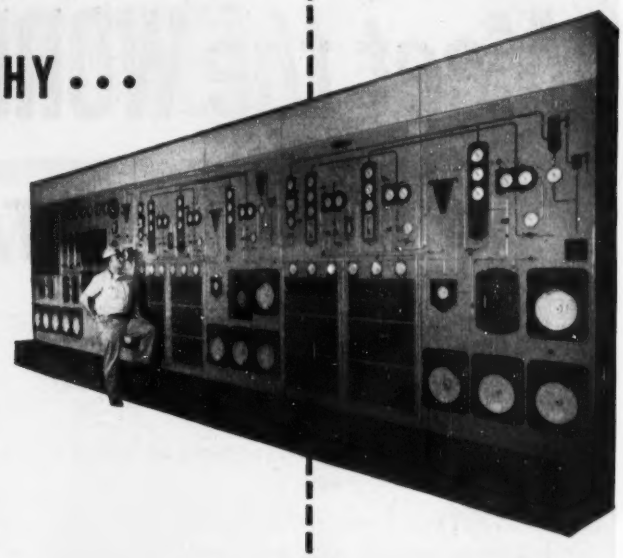

PANELLIT
PANALARM
PANASCAN
WELCOME YOU TO CHICAGO
for the I.S.A. Conference
DON'T MISS THIS OPPORTUNITY
to tour our plants
You are cordially invited to visit with us.
During the entire Instrument Conference, tours will be conducted in small groups through all five PANELLIT plants in Chicago.

For more information circle 15 on inquiry card.

6 REASONS WHY . . .

PANELLIT is the largest builder of process control panels



1 **SPECIALIZED ENGINEERING . .** combining instrumentation and process experience, PANELLIT provides sound and economical engineering as a part of their service.

2 **ADVANCED STANDARDS OF CONSTRUCTION . . .** have distinguished PANELLIT in every detail of structure, finish, piping, terminal arrangements and serviceable behind-the-panel layouts.

3 **PIONEERING CONCEPTS OF INSTRUMENTATION . . .** the graphic control panel, miniature instrumentation, unitized annunciator systems, scanning and monitoring devices . . . all have been closely associated with PANELLIT.

4 **ORGANIZATIONAL FLEXIBILITY** . . . Few process control panels are ever shipped without changes. When "change orders" are received, PANELLIT moves quickly to carry them out . . . without confusion . . . without delay. Where others take weeks, PANELLIT takes hours.

5 **THE ONE MAN PLAN . . .** makes PANELLIT easy to work with. One project engineer stays with your job. There are no "pass along instructions" or "round about authority".

6 **INFORMATION SYSTEMS . . .** an advanced PANELLIT concept of the control panel has resulted in better process control. An *information system* filters information for the operator to know . . . and presents it in a manner that he may act quickly and instinctively. *Write for complete information.*

PANELLIT

INFORMATION SYSTEMS

PANELLIT, INC., 6312 N. BROADWAY

CHICAGO 40, ILLINOIS

For more information circle 15 on inquiry card.

WHAT'S NEW AT BRISTOL...

Meet the WORLD'S SIMPLEST

It's Bristol's new METAGRAPHIC Pneumatic

for measuring, indicating, recording and controlling pressure, temperature, vacuum, flow, differential pressure, and liquid level

Here are a few of the advantages of Bristol's METAGRAPHIC system:

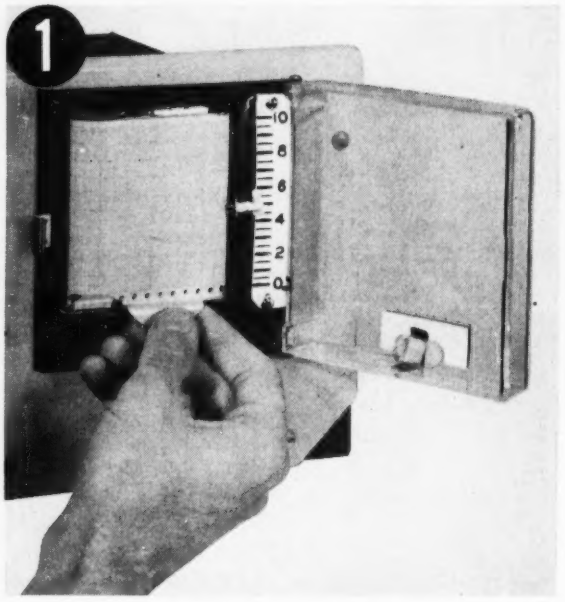
SIMPLICITY... fewer moving parts, fewer adjustments needed, and less service required. Range changes can be made in seconds.

FLEXIBILITY... all components are interchangeable. Units can be combined like building blocks to make up any kind of arrangement; functions can be located exactly where they're needed.

TRUE PLUG-IN SERVICE... provides great savings in installation costs. And if trouble is suspected with any component, just pull the doubtful unit out and plug in a stand-by—*without stopping any processing.* The suspected unit can be taken to the shop and checked whenever time permits. You don't lose any air pressure when changing units, either. Bristol's automatic sealing system prevents loss of signal to other components.

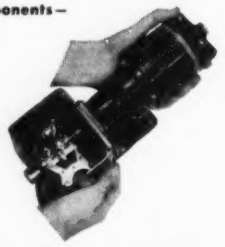
NO TIME LAGS... in a four-pipe circuit the transmitter signal and the controller-output signal travel around a very short loop—which can be as little as three feet long.

These are some of the important advantages of Bristol's METAGRAPHIC instrument system—the product of over 60 years of experience in instrument making and application in practically every industry. Get the whole story by writing to The Bristol Company, 113 Bristol Road, Waterbury 20, Conn.



IT TAKES ONLY SECONDS to change the Bristol METAGRAPHIC receiver from a recorder to an indicator: Case door is opened...

Here are the basic components—



BRISTOL PNEUMATIC TRANSMITTER, with cover removed to show simplicity of the world-famous Bristol measuring element. The frictionless transmitter, with only one pivot and no flexures, will operate in any position, indoors or out. The unit is sensitive to extremely small changes in the measured quantity, as minute as 0.03% of range, including reversal.

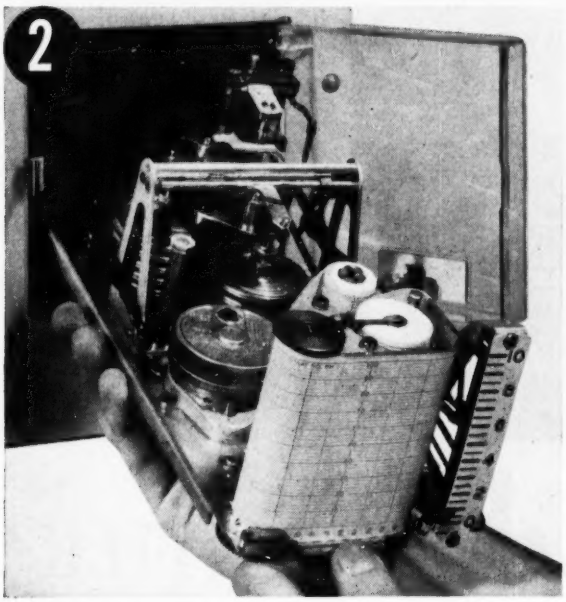
These instruments will be on exhibit in booths 95, 96, 97 at the ISA Show in Chicago.

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

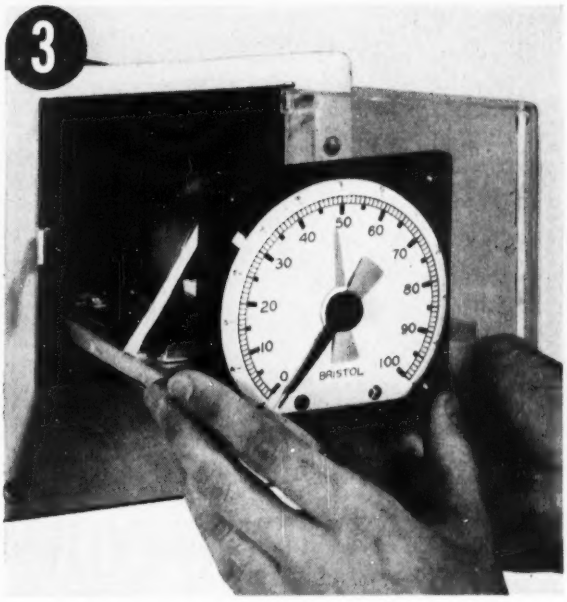
For more information circle 16 on inquiry card.

INSTRUMENT SYSTEM!

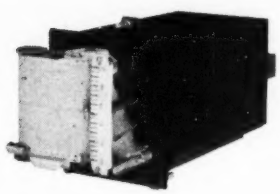
Transmission instrument system . . .



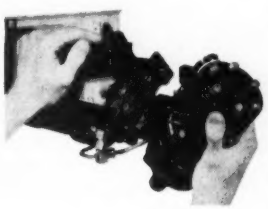
Recorder chassis withdrawn from case (air pressure is automatically maintained) . . .



Indicator chassis is plugged into same case. Control remains undisturbed throughout change-over.



HERE'S THE RECORDER CHASSIS, in retracted position. Now pen can be inked, set point and zero adjustment made without disturbing record or control. You can bring up to three related variables, such as flow, pressure and temperature, into one receiver. Auto-manual switching is foolproof and "bumpless," without disturbing valve position.



THE BRISTOL CONTROLLER can be plugged into back of receiver, placed at process, or used as a "blind controller." Available in on-off, proportional, proportional plus reset, proportional plus derivative, and proportional plus reset plus derivative. Experienced instrument men will recognize this as a unit service-proved by thousands of installations.*

*Licensed under C. B. Moore patents

LOOK FOR OUTSTANDING NEW DEVELOPMENTS FROM BRISTOL

BRISTOL

THE DEPENDABLE GUIDEPOST OF INDUSTRY

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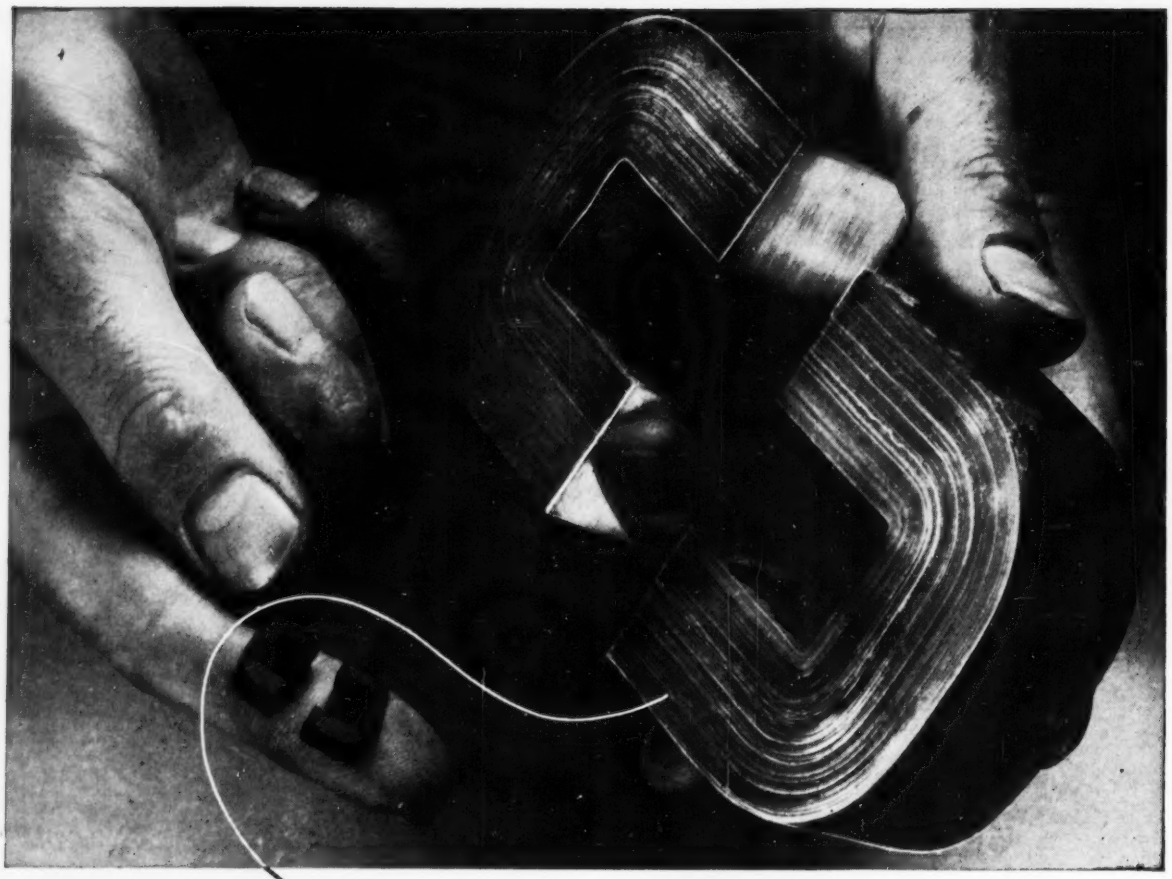

SILECTRON C-CORES...BIG or LITTLE

...any quantity and any size

Wound from precision rolled oriented silicon steel strip as thin as .00025"

WAD 4363

For users operating on government schedules, Arnold is now producing C-Cores wound from ¼, ½, 1, 2, 4 and 12-mil Silectron strip. The ultra-thin oriented silicon steel strip is rolled to exacting tolerances in our own plant on precision cold-reducing equipment of the most modern type. Winding of cores, processing of butt joints, etc. are carefully controlled, assuring the lowest possible core losses, and freedom from short-circuiting of the laminations.

We can offer prompt delivery in production quantities—*and size is no object, from a fraction of an ounce to C-Cores of 200 pounds or more.* Rigid standard tests—and special electrical tests where required—give you assurance of the highest quality in all gauges. ● *Your inquiries are invited.*

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

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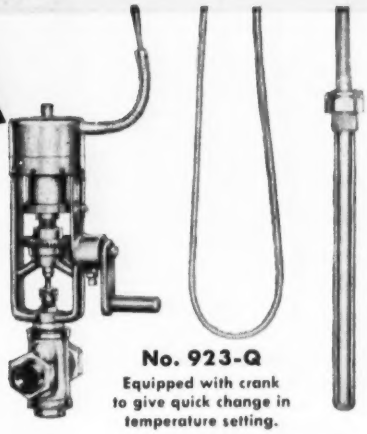
For more information circle 17 on inquiry card.

No. 999
Has large-size, 2-ply Sylphon bellows for added power. Over-temperature protection.

No. 926
Safety Type. Has "Fail Safe" feature.

CHOOSE YOURS!

No. 998 Series
Recommended where a wide range of temperature adjustment required. Over-temperature protection.



No. 923-Q
Equipped with crank to give quick change in temperature setting.

Sylphon Regulators for automatic temperature control – cost control, too!

● Whatever your need for automatic control of temperature of liquids, air or gases, it's a safe bet a Sylphon Regulator can handle the job. And do it accurately, dependably, and at a savings.

Sylphon Regulators eliminate "guess-work" temperature control. Many of them can be equipped with dial-indicating thermometer; some have "over-run" feature for over-temperature protection. They save manpower, man-hours and fuel.

Four Regulators of the complete Sylphon line are pictured here. Write for information. Tell us your specific needs or operations; we'll help you select the Sylphon Regulator that will do the job as *you* want it done! Please address Department PE.

Some of the uses for SYLPHON TEMPERATURE REGULATORS

Storage water heaters
Metal plating tanks
Bottle washers
Treaters
Slashers
Fuel oil preheaters
Petroleum heaters and treaters
Chemical heating tanks
Heating of water for showers
Engine and compressor cooling
General industrial processing applications

See the Fulton Sylphon display at the 8th National Instrument Exhibit — Booths 159, 160, 161.

Robertshaw-Fulton
CONTROLS COMPANY

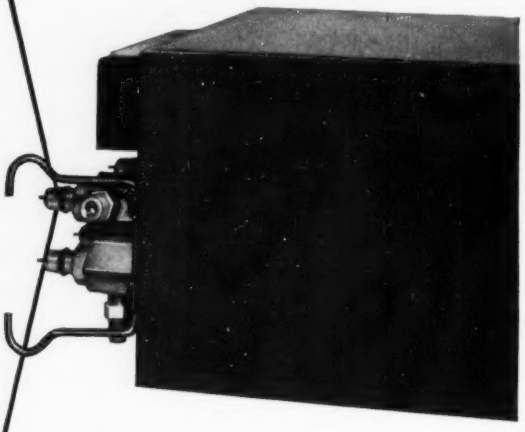
FULTON SYLPHON DIVISION
Temperature Controls · Bellows Devices · Bellows Assemblies
KNOXVILLE 1, TENN.

For more information circle 18 on inquiry card.

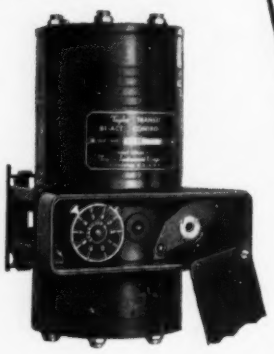
SEE TAYLOR

at the ISA Show — Booths 131, 132, 133

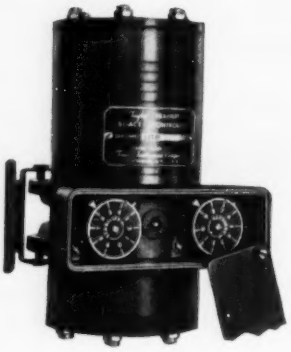
We'll be demonstrating Taylor versatility on a full size graphic panel section. You will see how the exclusive TRANSET* Plug-In feature enables the process engineer to quickly select or change both controllers and receivers to meet requirements as they develop. He can use the One Knob or Two Knob BI-ACT* or TRI-ACT* Controllers, depending on the control



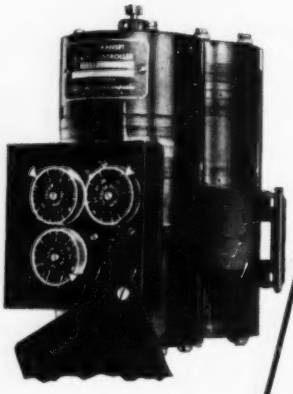
PLUG-IN CONTROLLERS



The One-Knob BI-ACT Controller is designed for use in industrial processes with short time lags, such as close-coupled liquid flow, fast pressure and comparable temperature problems. Combines simplicity of adjustment and economy.



The Two-Knob BI-ACT Controller will cover the full range of reset rate and proportional response adjustments. This makes it more satisfactory for those jobs that have longer time lags, and where close response adjustments are essential to good performance.



The Brand New TRI-ACT Controller combines all 3 response adjustments (gain, reset rate and Pre-Act response). It is the most complete controller, giving the very best control on the more complex processes, particularly those with long time constants, and load changes requiring both derivative and reset adjustments. Gives faster recovery on load changes; start-up without overpeaking; the benefits of automatic reset without its evils.

HERE'S WHAT *VERSATILITY* MEANS TO YOU!

1. You can plug in shop-adjusted instruments.

2. You can efficiently analyze process difficulties by quickly substituting a recorder for an indicator.

3. You can switch from the simplest to most complete controller in a matter of seconds.

4. Down time is kept to a minimum, since both controllers and receivers plug in.

5. Maintenance is unnecessary in the area of

TAYLOR INSTRUMENTS

For more information circle 19 on inquiry card.

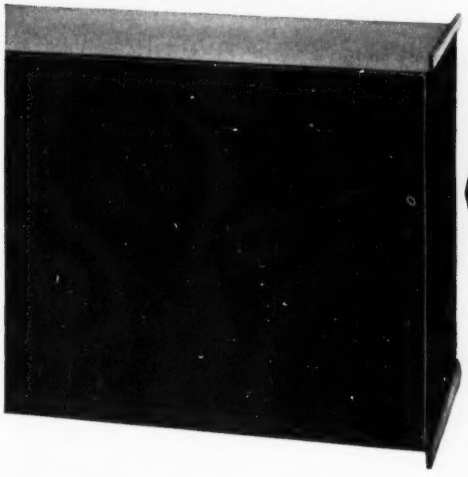
VERSATILITY

quality required or conditions encountered; he can switch, in seconds, from an indicating to a recording receiver, with or without automatic-to-manual features, or with cascade (pneumatic set) features. In other words, second thinking is both practical and economical.

Both Controllers and Receivers are designed to take advantage of the speed of response and high accuracy of the TRANSAIRE* transmitters —for temperature, pressure or differential pressure.

Be sure to see us at the show! Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.*

*Trade-Mark



the panel. Checking can be done in the shop where full facilities are available.

6. One standard panel cut-out (5 1/32" x 4 5/32") accommodates 12 different forms of recording and 11 different forms of indicating receivers.

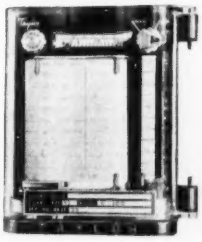
7. You conserve panel space without impairing maintenance facilities.

8. Self-purging case for all receivers is especially appreciated in corrosive or dusty atmospheres.

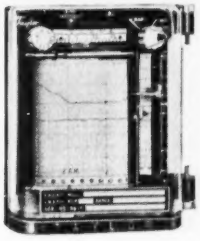
9. Your plant can be kept running smoothly, without expensive shutdowns.

PLUG-IN RECEIVERS

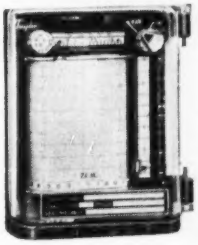
The TRANSET Indicator has all the features of the TRANSET Recorder, but gives no chart record. Gives direct indication of both set point and process variable on single, easy reading 3½" dial. *Mounts in same size panel opening as TRANSET Recorder.*



The TRANSET Recorder has automatic-manual unit, remote set-point indicator. 30 day linear chart, 3 hours visible. Chart reads from left to right on rectilinear coordinates, as an engineer would normally plot variables for study.



The Single Duty Bi-Record Receiver can record a related variable in addition to that under control. For example, in flow measurement it records static pressure as well as differential pressure.



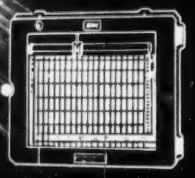
The Pneumatic Set Receiver (Cascade) combines in *one* case without additional panel space the facilities for pneumatic set, automatic control and automatic-to-manual feature.

MEAN ACCURACY FIRST

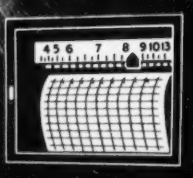
For more information circle 19 on inquiry card.

FOR LEADING MAKES OF MECHANICAL RECORDERS

NEW!



ELECTRONIC CONVERSION KITS



Put a New Heart in Your Mechanical Recorder at 66% Less Cost to You!

Enjoy . . .

- freedom from maintenance
- increased sensitivity and speedier response that comes with up-to-date electronic action.

Ideally suited for obsolete pyrometer conversion.

Simplify stocking—the same amplifier serves all four major makes of mechanical recorders.

Conversion kits complete with instructions and photographs shipped from stock.

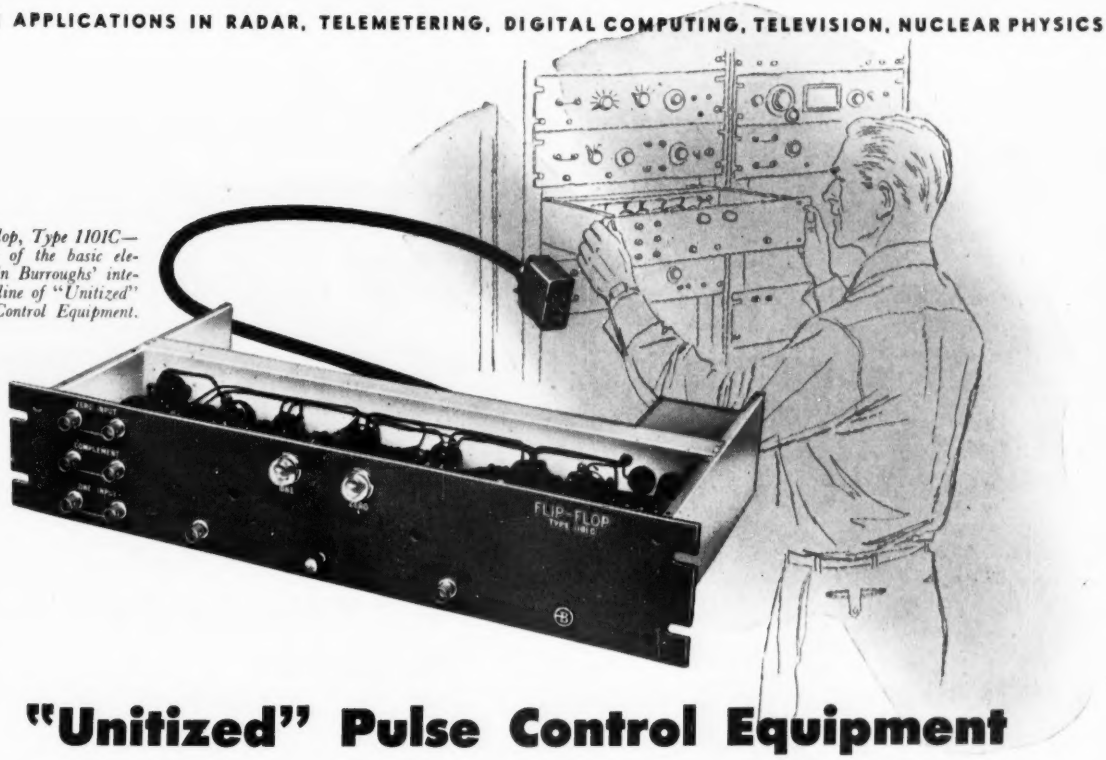
For more information and fully descriptive literature write to

PYROMETER SERVICE CO.

348 River Road, North Arlington, N. J.

For more information circle 20 on inquiry card.

FOR APPLICATIONS IN RADAR, TELEMETERING, DIGITAL COMPUTING, TELEVISION, NUCLEAR PHYSICS



Flip-Flop, Type 1101C—another of the basic elements in Burroughs' integrated line of "Unitized" Pulse Control Equipment.

"Unitized" Pulse Control Equipment

saves time and money in electronic engineering

There's no longer any need to tie up engineering personnel with the time-consuming work of developing and "breadboarding" electronic test circuits. Burroughs, a leader in the office machine industry, now offers an integrated line of "Unitized" Pulse Control equipment covering all the basic functions in pulse circuit engineering. These one-basic-function units are designed with a maximum of flexibility to be used as building blocks for test systems ranging from the very simple to the most complex. Engineers need only make a block diagram of the apparatus needed, assemble the necessary Burroughs units in the plug-in rack, and interconnect them with the various standard coaxial cables and accessories. It's really that easy! It's equally easy to reassemble your units for a different project when your present tests are completed.

YOU SIMPLY "PLUG IN" BURROUGHS FLIP-FLOPS

Burroughs Flip-Flop, Type 1101C, demonstrates the one-basic-function principle that makes Burroughs "Unitized" Equipment so suitable for your needs.

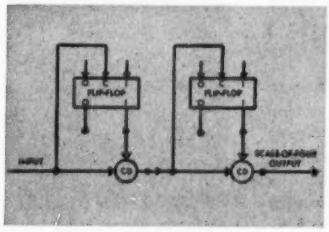
This flip-flop is a bistable circuit designed specifically to provide an output gating voltage to be used in coincidence circuits. The unit contains a pentode Eccles-Jordan circuit capable of being switched at rates up to 2.5 megacycles per second, with 0.1 microsecond pulses.

There are three inputs—Zero, One and Complement—operating from pulse amplitudes of 12 volts or more. Coaxial output jacks marked "Zero Gate" and "One Gate" supply either 0 volts or -23 volts at an impedence level of approximately 680 ohms.

Two neon lights on the front of the panel indicate the position of the flip-flop. A terminal block on the rear of the unit can be used to operate indicator lights installed at a remote point for visual monitoring.

Proved by more than two years of constant use, Burroughs "Unitized" Pulse Control equipment has been purchased by many leading electronic research organizations. Some of the users are: Massachusetts Institute of Technology, University of Michigan, Stanford Research Institute and National Union Radio Corporation.

Scale-of-Four Binary Counter Using Burroughs "Unitized" Equipment



The left flip-flop, Type 1101C, changes state with each input pulse, so that the left coincidence detector (CD) or gate, Type 1201B, is alternately opened and closed with succeeding input pulses, with the result that every other input pulse passes through the left coincidence detector, giving a count of 2. A similar flip-flop and gate combination cascaded to the first combination gives a total scale of 2 x 2 = 4. The number of flip-flop and coincidence detector combinations that can be cascaded is unlimited.

For full information on Burroughs "Unitized" Pulse Control Equipment, write or call Department 15B, Electronic Instruments Division, Burroughs Corporation, 511 N. Broad St., Philadelphia 23, Pa.

PULSE GENERATORS
COINCIDENCE DETECTORS
PULSE DELAYS
FLIP-FLOPS
PULSE GATERS
CHANNEL SELECTORS
MIXERS

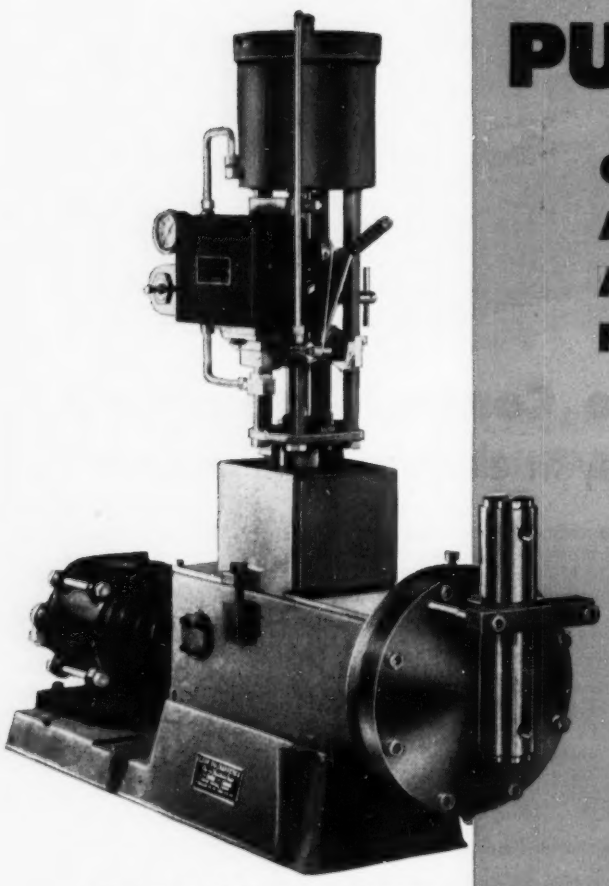
ELECTRONIC INSTRUMENTS DIVISION
Burroughs
THE BEST KNOWN NAME IN OFFICE MACHINES

For more information circle 21 on inquiry card.

NOW!

Lapp *Auto-Pneumatic* PULSAFEEDER

OPERATES AT FULL CAPACITY AND FULL RATED PRESSURE



The Lapp Auto-Pneumatic Pulsafeeder has made possible automatic continuous processing in many processes involving chemicals or mixtures which have not been satisfactorily handled by pumps of conventional construction. In this construction, pumping rate is controlled by instrument air pressure responsive to variable flow, pH, temperature, liquid level, pressure, or any other instrument-measurable processing variable. And now, new improved Auto-Pneumatic instrumentation provides for greater capacity and/or pressure—full ratings as listed for manually-controlled models.

TWO PUMPS IN ONE!

Lapp Pulsafeeder is the combination piston-diaphragm pump for controlled-volume pumping of fluids. Reciprocating piston action provides positive displacement. But the piston pumps only an hydraulic medium, working against a diaphragm. A floating, balanced partition, the diaphragm isolates chemical being pumped from working pump parts—eliminates need for stuffing box or running seal. Constant pumping speed; variable flow results from variation in piston-stroke length —controlled by hand-wheel, or, in Auto-Pneumatic models, by instrument air pressure responding to any instrument-measurable processing variable.

WRITE FOR BULLETIN 300 with typical applications, flow charts, description and specifications of models of various capacities and constructions. Inquiry Data Sheet included from which we can make specific engineering recommendation for your processing requirement. Write Lapp Insulator Co., Inc., Process Equipment Div., 126 Wilson St., Le Roy, N.Y.

SEE US AT THE INSTRUMENT SHOW—BOOTHS 51-52

For more information circle 22 on inquiry card.

Whether you want 1 or 1,000,000 gauges no maker's mark means more to you than USG

When you specify a United States Gauge you automatically benefit these ways:

1. You avail yourself of all the skill, experience, facilities and manufacturing know-how of the world's largest maker of gauges.

2. You gain the ingenuity that, for the past 47 years, has been applied to almost every type of gauge—the brains of top engineers and producers in a complex and exacting business.

3. You assure yourself the degree of accuracy you specify, whether it's USG laboratory precision, any of the ASA recognized standards, or special requirements for accuracy or duty demanded by Underwriters' Laboratories, Inc., Factory Mutual, or various U. S. Government agencies. Over 55 tests and inspections check quality before shipment.

4. You enjoy uniformity in manufacture, for USG is the only company of its kind producing all its parts in its own plant.

5. You inherit the technical advances of the United States Gauge Experimental Laboratory, the finest gauge development group in the nation.

SPECIAL INSTRUMENT DEVELOPMENT

USG not only manufactures all types of commercial gauges but also many highly specialized instruments measuring from less than 1" of mercury absolute to 150,000 p.s.i.

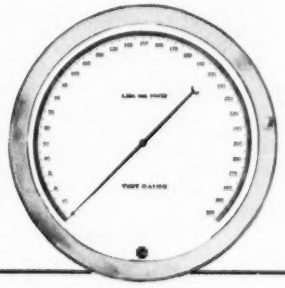
UNITED STATES GAUGE STANDARDS LABORATORY

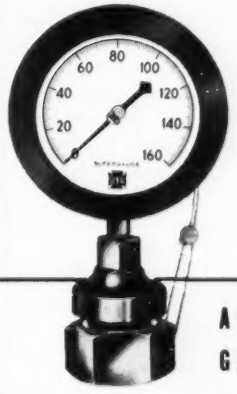
A completely modern laboratory equipped with many different primary masters covers the entire range of pressure sensing instruments. It contains, for example, absolute masters with a range of .005 to 1050 microns absolute and pressure-sensitive cells with a range of 0 to 150,000 p.s.i.

Write today for information about USG instruments. United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Penna.

16" LABORATORY TEST GAUGE

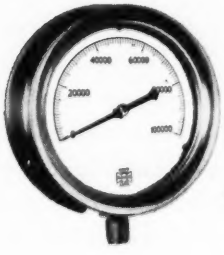
Accuracy—½ of 1% of the indicated reading above 20% of the maximum dial range and 0.2% of full scale over balance. Furnished with Certified Test Report. Sensitivity as high as 1 part in 10,000. Ranges 15 to 20,000 p.s.i. standard; special 30,000 p.s.i. or over.





CHEMICAL GAUGES

Cleanout and protected types. Cleanout type used for viscous liquids requiring periodic cleaning; protected type designed for low-viscosity liquids. These gauges are rugged, will stand high overpressure. Ranges 30" vacuum to 1500 p.s.i.



HIGH PRESSURE SOLID FRONT GAUGES

For testing high pressure gases and liquids. Built to highest possible standards. Accuracy 1% of full scale reading up to 50,000 p.s.i., 2% of full scale reading on pressures over 60,000 p.s.i. Ranges 100 to 150,000 p.s.i.

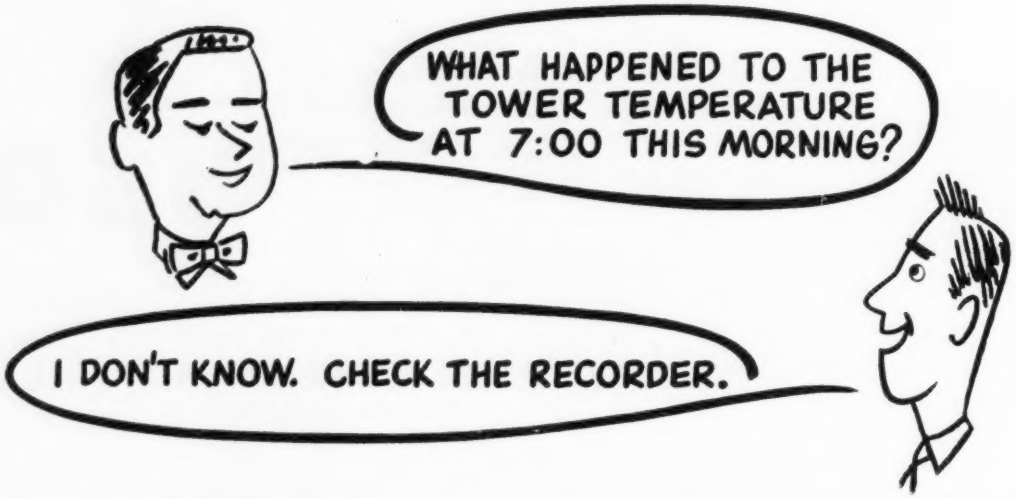
ABSOLUTE PRESSURE GAUGE

A highly accurate, dependable instrument for measuring absolute pressures. Ranges: 0 to 20 millimeters to 10 to 100 inches of mercury.

UNITED STATES GAUGE

PRODUCTS OF UNITED STATES GAUGE . . . Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges • Boiler Gauges • Chemical Gauges Mercury, Gas, and Vapor Dial Thermometers • Glass Tube and Industrial Thermometers • Flow Meters • Inspectors' Test Gauges • Precision Laboratory Test Gauges • Marine, Ship and Air-Brake Gauges • Voltmeters • Ammeters • Welding Gauges.

For more information circle **23** on inquiry card.



WHAT MAKES A RECORDER GOOD?

Many things. For instance, in the new Thermo Electronic indicating-recorder overall design is simple. The recording system only has three moving parts.

That's one thing. Here's another: the pen arm is driven from a cam. This permits linear charts to be used for almost all measurements, despite the non-linearity of the sensitive element characteristics. When warped or expanded scales are desired, special cams can be supplied.

Furthermore, nylon drive gears are used to provide long life and quiet operation.

There are many other things. If you want to hear about them, let us know. We'll be glad to supply the information. Ask for Catalog No. 60 F.

AT THE ISA SHOW

This indicating-recorder, along with T-E's other pyrometric equipment, will be at the Instrument Society of America Exhibit, Sherman Hotel, Chicago, Ill., Sept. 21-25, Booth 59.

Even if everything goes the way it should with any process where temperature is involved, sometimes it's important to *prove* everything went right. On the other hand, if something is wrong, if standards aren't met, then it's very important to *know* what went wrong in order to correct it. Was it temperature? Or some other process variable?

When an accurate temperature recorder is on hand, a quick check of the record will tell you if temperature was too high, or low, and for how long. If the temperature was off, your problem is pinpointed and you can work on it right away. If it wasn't, you can go on to other variables and find the troublemaker. Either way, a good recorder is a time-saver.

Thermo Electric makes a good recorder —it is accurate (±¼ of 1% of the range), sensitive (better than ±1/20 of 1%), durable, and can be used to record variations in temperature, humidity, solution conductivity, speed, pH, direct current, DC voltage, strain, or other variables. Both potentiometer pyrometer and resistance thermometer bridge types are available, depending on the application.

Thermo Electric Co., Inc.
FAIR LAWN NEW JERSEY

For more information circle **24** on inquiry card.

a teaspoonful of steam!

HERE'S THE ANSWER TO YOUR SMALL FLOW CONTROL PROBLEMS

a NEW LESLIE REDUCING VALVE

for accurate, foolproof regulation of small flows of steam, air, gas or liquids, with inlet pressures to 1000 psi and reduced pressures from 2 to 400 psi.

Change operating conditions quickly and easily with simple, handwheel adjustment —no need to waste time changing springs or swapping parts. Check these widely accepted Leslie features that are standard in the new, efficient, Leslie Small Flow Reducing Valve.

Check these features

- Simple, compact construction
- Top quality materials
- Metal Diaphragm
- Entirely enclosed—no stuffing boxes
- Corrosion resistant springs
- Hardened stainless steel valve
- Interchangeable inner valves

SEND FOR DESCRIPTIVE BULLETIN 511-A WITH *COMPLETE* CAPACITY TABLES

Before you order—

The new Class LCB is just one of the many units that are *special* with most manufacturers but are *standard* with Leslie.

Check to see if any pressure, temperature or level control you want is standard with Leslie, before you order. Play it safe. Your Leslie Engineer is listed under "Valves" or "Regulators" in the classified telephone directory in principal cities.

LESLIE

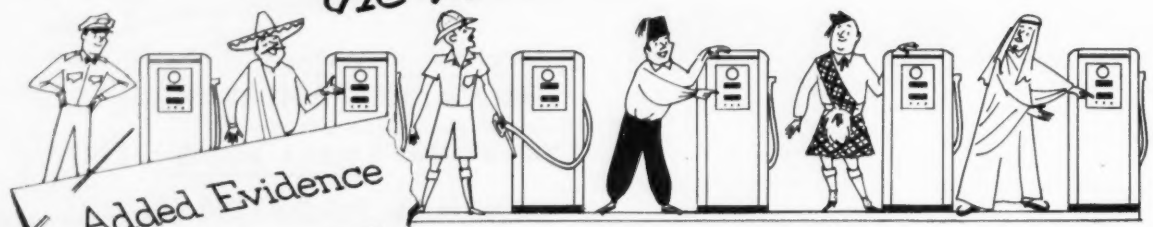
THE FIRST NAME IN PRESSURE, TEMPERATURE AND LEVEL CONTROLS

Since 1900

LESLIE CO., 299 Grant Avenue, Lyndhurst, New Jersey

For more information circle 25 on inquiry card.

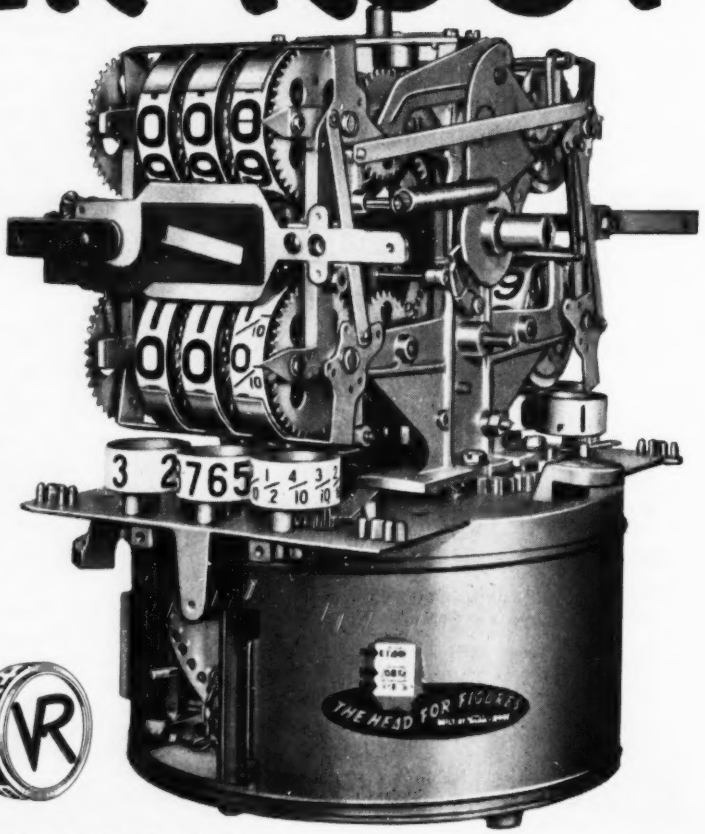
It Computes the Cost of Gasoline Pumped... in All of the World's Currencies



Everyone Can Count on

VEEDER-ROOT

Yes, this Veeder-Root Gasoline Pump Computer speaks the languages of 144 countries! A rugged, accurate mechanism of 800-plus parts, it's the modern protection given you by gasoline pump manufacturers, gasoline refiners and their service-station outlets . . . *to make sure you get full measure in your tank, and the right change in your pocket* (or you can buy in "even money"). And what's more, it underscores the fact that "Veeder-Root Counts Everything on Earth" . . . electrically, mechanically or manually . . . with standard and special devices of every conceivable type. Do *you* have a counting problem, in any of your defense work or any of your regular production? If so, you can count on V-R to help you in every possible way.



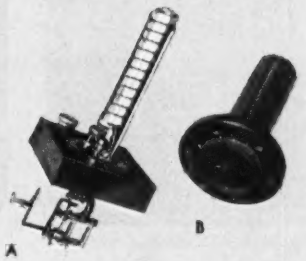
VEEDER-ROOT INCORPORATED
"The Name That Counts"
HARTFORD 2, CONNECTICUT
Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"Counts Everything on Earth"

For more information circle 26 on inquiry card.

Accurate Measurement of

HIGH DIFFERENTIAL PRESSURES



Heart of the Foxboro Type EH Differential Pressure Controller (below) is the heavy-duty stainless steel helical measuring element (A) with its alloy-steel housing (B). This assembly is mounted at rear of instrument case, the motion of the helical being transmitted to the instrument mechanism through a friction-free pressure seal bearing.

. . . at high statics!

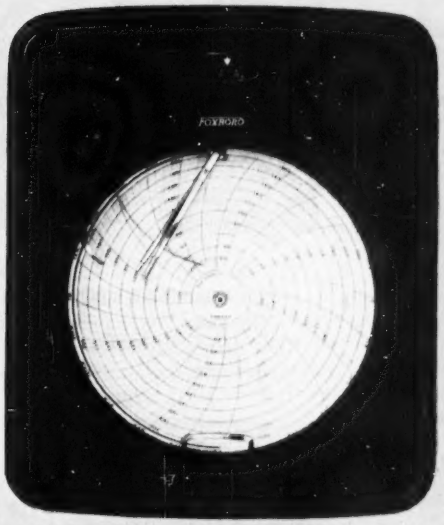
Differential pressure measurements at ranges far above the limits of conventional devices, and at statics up to 2200 psig, can be readily recorded and controlled by the new Foxboro Type EH Instrument.

Major chemical companies have employed this instrument to measure pressure loss across fixed catalyst beds. By operating until a pre-determined pressure loss indicates catalyst exhaustion, instead of shutting down and regenerating on a time cycle, they have increased production, cut costs.

Many large steam generating plants have installed Type EH Instruments to control differential pressure across boiler feed valves, thus assuring at all times that the boiler feed pump is operating at pressures high enough above boiler pressure to assure safe operation.

Differential pressure ranges are available from 0-100 psig minimum to 0-2200 psig maximum. Design of the helical actuating element assures precision over the entire measuring span. Heavy-duty construction of the element and its housing makes operation safe.

Write for details on Foxboro Type EH Instruments for indicating, recording, controlling, transmitting.



THE FOXBORO COMPANY, 468 NEPONSET AVE., FOXBORO, MASS., U.S.A.

FOXBORO
REG. U. S. PAT. OFF

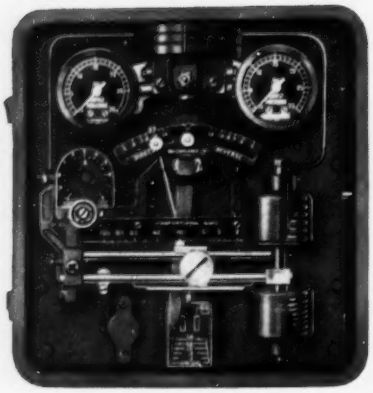
PRESSURE INSTRUMENTS

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

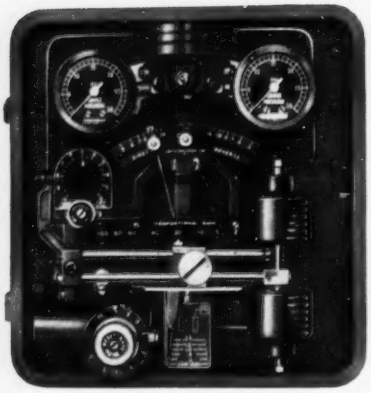
For more information circle 27 on inquiry card.

NEW MASONEILAN 12000 SERIES

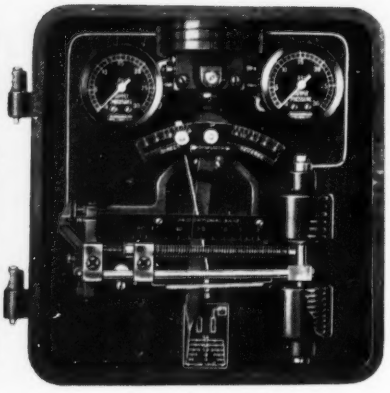
Easy to Select



Proportional Controller



Proportional-Reset Controller



Pneumatic Transmitter

20 INSTRUMENT COMBINATIONS

Proportional Controller, which may also be used as a Transmitter, and which may be converted *in the field* to a

Differential-Gap Controller by changing one piece of air tubing or to a

Proportional-Reset Controller by simple addition of the reset unit. Also

Pneumatic Transmitter; or if desired

Any Combination of Two of these — same or different units — in a larger case

Right Hand Mounting on Integral Chamber

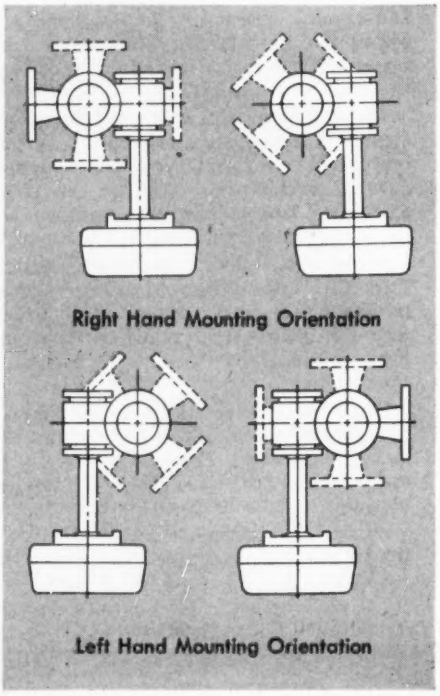
2 INSTRUMENT LOCATIONS

The instrument may be mounted to left or right of the displacer — at the factory — or in the field. No special tools — no extra parts required.

2 DISPLACER CHAMBERS 8 ORIENTATIONS

The instrument may be oriented to connections in any of eight positions when one or more side connections are used. *Mid-flange* in displacer chamber permits field orientation (or, if preferred, integral chamber with factory orientation can be supplied). Top and bottom connections permit installation of *integral* chamber in any desired position.

Left Hand Mounting on Mid-flange Chamber



Right Hand Mounting Orientation

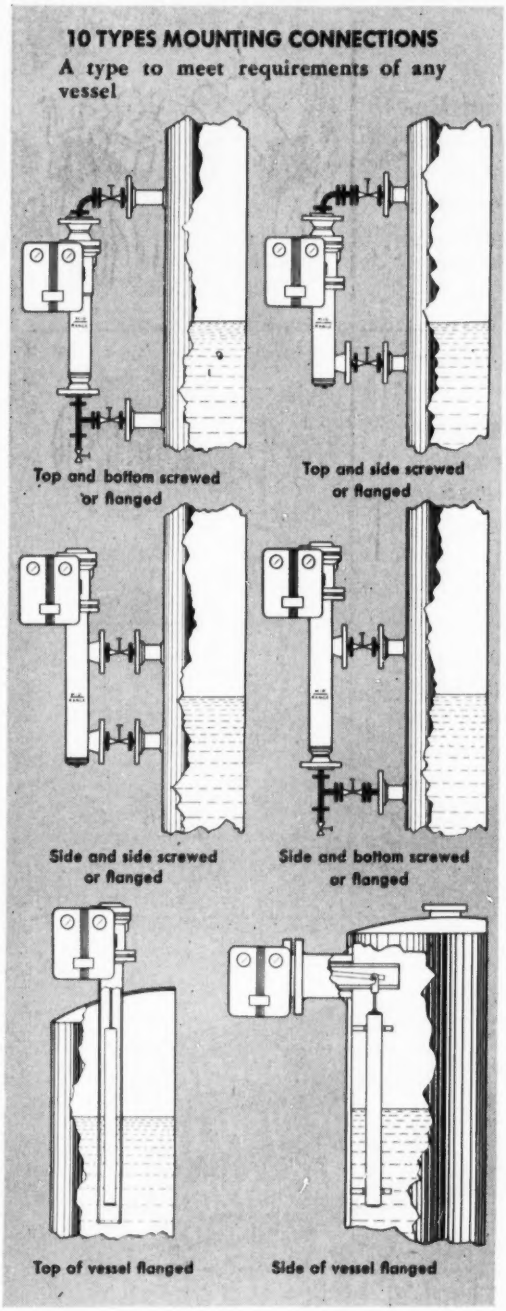
Left Hand Mounting Orientation

OVER 1,000,000

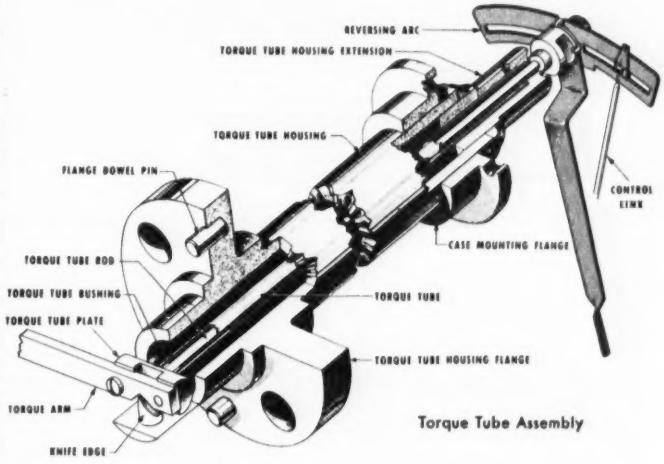
For more information circle **28** on inquiry card.

LIQUID LEVEL CONTROLLERS

and Install


10 TYPES MOUNTING CONNECTIONS
A type to meet requirements of any vessel
Top and bottom screwed or flanged
Top and side screwed or flanged
Side and side screwed or flanged
Side and bottom screwed or flanged
Top of vessel flanged
Side of vessel flanged

Save time — save money! Masoneilan 12000 Series offers widest scope of selection plus design features that permit installation without delay and cost of precise preliminary layout. Convertibility *in the field* — of type of control and of orientation of instrument position to displacer and to chamber connections simplifies selection and installation. Simplified dimension schedule further assists in installation plans.



Torque Tube Assembly

9 TORQUE TUBE MATERIALS

Inconel (standard), K-Monel, Monel, Type 316 Stainless Steel, Hastelloy B or C, Nickel, Phosphor Bronze, Durimet 20.

CHAMBER or FLANGE MATERIALS

Iron, Bronze, Carbon Steel or various* Alloys available on some chamber or flange types — carbon steel or alloys on all types

*e.g. Stainless Steel, Monel, Nickel, Hastelloy, etc.

8 STANDARD RANGES

14″, 32″, 48″, 60″, 72″, 84″, 96″, 120″
Special ranges available

ALL HIGH Quality Coefficient PRODUCTS

MASONEILAN REGULATOR CO.

1210 Adams Street, Boston 24, Mass., U. S. A.

POSSIBLE COMBINATIONS

For more information circle **28** on inquiry card.

PREVIEWS

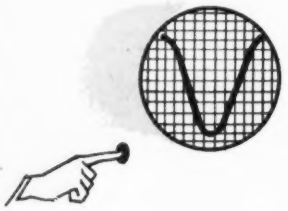
of things to see at the I.S.A. Exhibit

Beckman *division*

A new Beckman Recording Spectrophotometer... demonstrations of the Beckman line of automatic pH equipment for industry... and end-point process control through continuous analysis with the Flow Colorimeter.

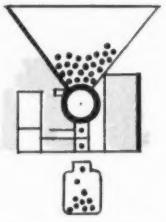
Helipot *division*

Push button demonstration...of the various functions generated by the Helipot line of non-linear precision potentiometers.



Berkeley *division*

New Preset Counter – electronic counting equipment capable of 40,000 counts per second with *absolute* accuracy... new Universal Timer and Counter... and permanent records of high-speed counting with the Berkeley Digital Recorder.



And... **plan to attend the Analytical Instrument Clinic. See the application of the Berkeley EASE Computer to today's process control problems. Write for advance registration form.**

...AT THE SPECIAL BECKMAN DISPLAY ROOM—SPACE #200

BECKMAN INSTRUMENTS, INC.

SOUTH PASADENA, CALIFORNIA

3-201

For more information circle 29 on inquiry card.

free . . .

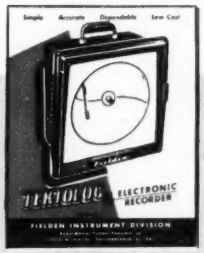
to men with instrumentation headaches

These 3 Fielden Bulletins Show You . . .

- How to save on original cost and maintenance of measuring, recording and controlling instruments.
- How to get all the instrument accuracy you need without paying for marginal precision.
- How to get dependable level control or indication of liquids, granular solids, viscous fluids and powders.

TEKTOR ELECTRONIC LEVEL CONTROL

Low cost, accurate level-limit control or indication of *nearly any substance that moves*. Simple to install—easy to adjust—foolproof in operation.



TEKTOLOG ELECTRONIC RECORDER

Accurate to ±1% of full scale or better—yet low in price because of simplified design and construction. Only 4 principal units—easily accessible. Easy installation. Minimum maintenance.

TELSTOR ELECTRONIC LEVEL INDICATOR

Trouble-free, inexpensive gauging of liquids or divided solids. No moving parts. No floats to stick or leak. No pneumatic or hydraulic piping to clog or leak. Gives accurate readings at remote stations. Easily installed. Easily serviced.

ALL FIELDEN ELECTRONIC INSTRUMENTS are designed and constructed in accordance with our new concept of simplified instrumentation. Result:—Rather surprising savings with no sacrifice of essential accuracy.

CHECK AND MAIL COUPON TODAY

☐ TEKTOLOG Recorder ☐ TELSTOR Indicator ☐ TEKTOR Control

Send me Technical Bulletins checked at left. No obligation.

*Name*_____

*Title*_____

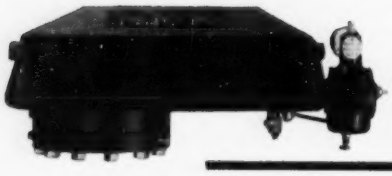
*Company*_____

*Address*_____

*City*_____ *Zone*_____ *State*____

Fielden
INSTRUMENT DIVISION
ROBERTSHAW-FULTON CONTROLS COMPANY
2920 N. 4th St., Dept. A Philadelphia 33, Pa.
Dollar for Dollar—Your Best Instrument Value

For more information circle 30 on inquiry card.

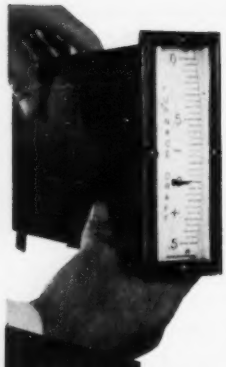


PNEUMATIC TRANSMITTER

requires little maintenance

A force-balance instrument that sends air pressure proportional to flow, level, pressure or liquid density. This output can be used as a measuring impulse for direct reading receivers or for actuation of an automatic controller. Operating principle permits rugged construction as well as high sensitivity and accuracy.

Republic



NEW DRAFT GAGE

Only five inches high, this new gage is an important step towards more compact control panels. For easy reading, dial is illuminated from the rear. Ranges 0-0.6" H_2O to 0-40" H_2O.

See Them in Operation at the Chicago I.S.A. Show

Visit Booth 84-85-86

Shown here are just some of the instruments and controls that Republic makes. They will be on display and most will be in operation at the Sherman Hotel, September 21-25. You'll be able to see how the equipment works, what its features are, and how they apply to your problems. Stop by—talk with our experienced instrument and control engineers—operate much of this equipment yourself—and evaluate Republic instruments and controls in terms of your needs. You'll find the time spent at Booth 84-85-86 interesting and profitable.

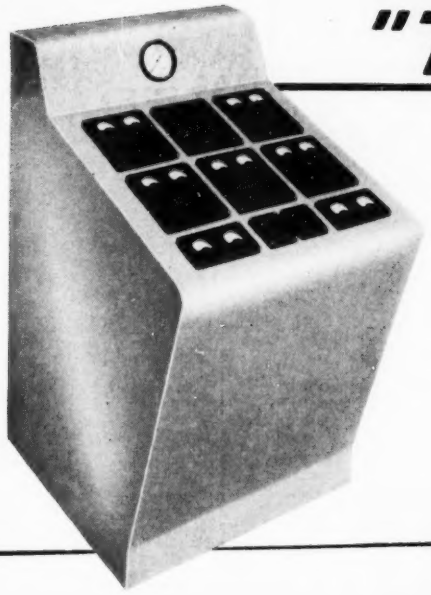
Also See Our Portable Instrument Calibrators

If You're Not Attending the Show . . .

you can still get full facts about this equipment as well as about all of the Republic line. Write for bulletins on any of the above equipment or get our general catalog which lists all of the control equipment Republic makes. There are branch offices and representatives in all principal cities who will be glad to supply any details you may want.

REPUBLIC INSTRUMENTS AND CONTROLS

For more information circle 31 on inquiry card.



"TELEMASTER"

electronic system permits centralized control with no transmission lag

A major advance in the field of automatic control, the TeleMaster coordinates and controls boilers, furnaces and processes from a central location through electrical and electronic means. It will remotely reproduce a position or a force—it can perform arithmetical or algebraic calculations. Transmission is accurate and almost instantaneous with no pneumatic lags. Operations can be centralized on one control panel at any reasonable distance from control equipment. With no panel piping required, control panels can be smaller, easier to operate and monitor. A constant check-back system assures accurate control. Proven in service, TeleMaster has been selected to control boilers generating a total of 50 million lbs. of steam per hour.

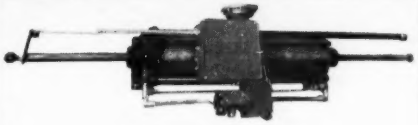
INSTRUMENTS and CONTROLS

STEEL MILL EQUIPMENT

FURNACE PRESSURE REGULATOR

stays in service

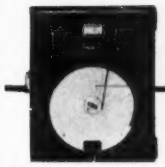
Mechanically controls valves and louvres to maintain furnace pressure constant. Extremely sensitive measuring element is integral with regulator. Unit is ruggedly built for dependable, low maintenance operation. A variety of control actions are possible with this regulator.



HIGH SPEED POSITIONING OPERATOR

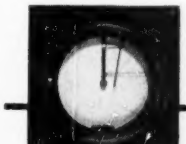
moves heavy loads quickly

High capacity pilot valve overcomes starting friction and inertia. Overtravel due to inertia is prevented by compensating linkage on pilot valve. Designed for heavy equipment such as furnace doors.



ELECTRIC FLOW METER

Continuous integrator — an exclusive feature with Republic — accurately totalizes all flow, permitting accurate control and accounting. Meter is completely enclosed in a steel case to keep dust and dirt out. Electric transmission of flow information permits mounting reading instruments at control panel with no loss of sensitivity or transmission speed.



LOW PRESSURE RECORDER

easily serviced

Measures low pressures in open hearth furnaces, soaking pits, reheating furnaces, coke ovens and smelting furnaces. May also be connected across an orifice to measure flow. Ranges 0-0.2" H_2O to 0-8" H_2O at static pressures to 10 psi. Mineral oil seal may be removed for cleaning without changing calibration.

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway, Chicago 47, Illinois

For more information circle 31 on inquiry card.

Announcing the **STANDARD** ELECTRONIC TACHOMETER

for P·R·E·C·I·S·E·L·Y measuring speed and frequency

- Takes Less Space (12" x 12" x 8")
- Uses Less Power (100 Watts)
- Has Fewer Tubes (Twenty-two)

EASIER TO READ . . . MORE RELIABLE . . . UNIT PLUG-IN CONSTRUCTION

SINCE 1884

STANDARD

Write for Bulletin #200

The STANDARD ELECTRIC TIME COMPANY

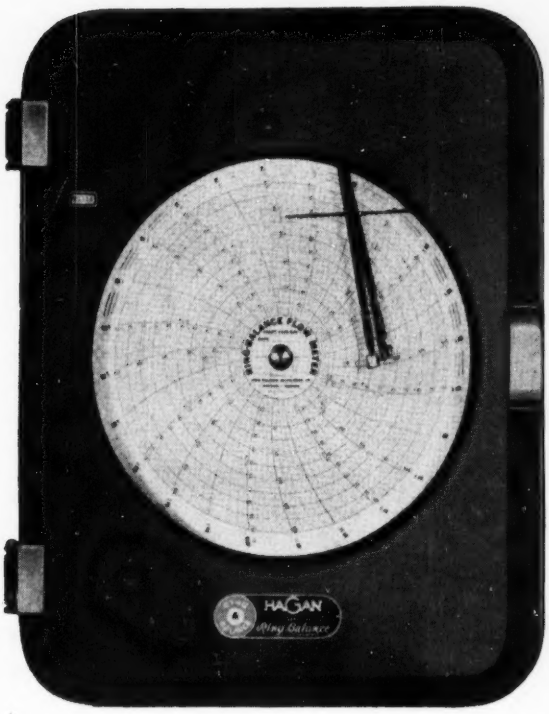
93 LOGAN STREET • SPRINGFIELD 2, MASSACHUSETTS

PRECISION TIMERS • CHRONO-TACHOMETERS • LABORATORY PANELS • PIPELINE NETWORK ANALYZERS

For more information circle 32 on inquiry card.

For accurate, automatic compensation
for temperature—
for pressure—
for density—or for position

Install Hagan Compensated Ring Balance Meters



The Hagan Compensated Ring Balance Meter automatically adjusts pressure differential or flow readings to correct for variations in temperature, pressure, density or mechanical positioning.

For flow measurements, the built-in integrator totalizes the corrected flow automatically.

Any measurements, such as drum level, steam flow, or any of the variants such as temperature, pressure, or density may be indicated or recorded on the same chart with the corrected record.

Send coupon for Bulletin M-51.

HAGAN CORPORATION
HAGAN BUILDING, PITTSBURGH 30, PA.
Boiler Combustion Control Systems
Ring Balance Flow and Pressure Instruments
Metallurgical Furnace Control Systems
Control Systems for Aeronautical
and Automotive Testing Facilities

Hagan Corporation
Hagan Building • Pittsburgh 30, Pennsylvania

Please send me further information on Hagan Ring Balance Meters. I am particularly interested in _____

NAME _____

POSITION _____

COMPANY _____

STREET AND NUMBER _____

CITY _____ ZONE ____ STATE _____

I-8

For more information circle 33 on inquiry card.

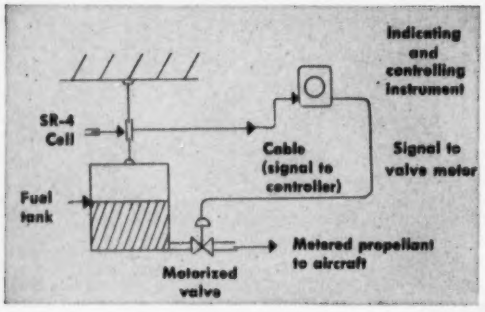
THE PROBLEM

For their rocket engine research and production, Bell Aircraft Corporation was designing a new instrumentation system. Their problem was finding a way to meter the propellant consumption remotely.

THE BALDWIN SOLUTION

Bell's requirements were met by a Baldwin SR-4 special type U Load Cell with a 160 pound capacity. As indicated in the sketch at left center, the fuel feed tank is suspended from a cable which is attached to the load cell so that the entire gross weight of the tank and fuel is supported by the cell.

SR-4 DEVICES IN INDUSTRY...
USES UNLIMITED



This system benefits Bell in these three ways:

1. The fuel consumption can be indicated and controlled remotely because the only connection from the SR-4 cell to the instrument is through electric cable.

2. Because of special aluminum construction this cell resists corrosion by common propellants such as hydrogen peroxide and nitric acid provided that cell is washed off after any accidental contact with them.

3. The need for maintenance is virtually eliminated by the rugged construction and by the absence of moving parts.

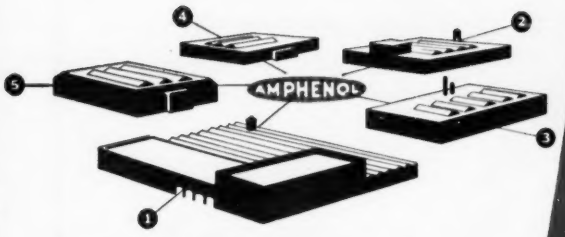
The uses of SR-4 devices throughout industry are unlimited. For further information about how they might cut your costs and time for measuring loads, pressure or torque, please write Dept. 3115, Baldwin-Lima-Hamilton Corporation, Philadelphia 42, Pa.

TESTING HEADQUARTERS

BALDWIN - LIMA - HAMILTON

General Offices: Philadelphia 42, Pa. • Offices in Principal Cities

For more information circle 34 on inquiry card.



for critical links in quality circuits

Shown here are a few of the more than 9,000 AMPHENOL components for power, control and instrument circuits. The majority were developed in close cooperation with government and customer engineers to meet specific needs in the electronic industry.

AMPHENOL can usually supply just the right connector or cable needed for a particular circuit from this wide selection. If your needs are special, AMPHENOL Engineers will work with you in the development of a custom component to meet your most exacting requirements.

Whether for product use, manufacturing and testing equipment or laboratory instruments—long, efficient performance is assured when you specify AMPHENOL components.

Specify AMPHENOL components

RACK and PANEL TYPE CONNECTORS

AN TYPE CONNECTORS

RF TYPE CONNECTORS

AUDIO CONNECTORS

POWER PLUGS

BLUE RIBBON CONNECTORS

INDUSTRIAL SOCKETS

MINIATURE SOCKETS

TUBE SOCKETS and RADIO COMPONENTS

MICROPHONE CONNECTORS

RG COAXIAL CABLES

TEFLON and POLYETHYLENE CABLE and WIRE ASSEMBLIES

PLASTICS—EXTRUDED and INJECTION MOLDED

Write today for your copy of General Catalog B-2

AMERICAN PHENOLIC CORPORATION
chicago 50, illinois

For more information circle 35 on inqui

I-P-S invites You . . .

WORLD'S LARGEST MANUFACTURER

PYROMETER & THERMOCOUPLE EXTENSION LEAD WIRE

Extends an invitation to all PYROMETER ENGINEERS, MAINTENANCE MEN, BUYERS, PLANT EXECUTIVES to visit our Booth No.'s 212-213 at the I. S. A. Eighth Annual Exhibit—Sept. 21 to 25 and receive an invitation for an enjoyable evening.

INDUSTRIAL PYROMETER AND SUPPLY Co. ALTON, ILL. U.S.A.

You are cordially invited
(bring the ladies)
to visit us in the
Century Room
La Salle Hotel, Chicago
from 9 p. m. til?
Monday, Tuesday and Thursday
September 21st, 22nd, and 24th, 1953

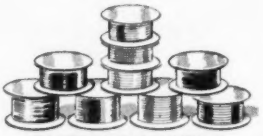
Refreshments—Bar—Dancing
Entertainment

Your Hosts:
Avery Hack *Frank Hack*
INDUSTRIAL PYROMETER and SUPPLY CO.
Alton, Illinois, U. S. A.

See our Booth Numbers 212 and 213
at the Sherman Hotel

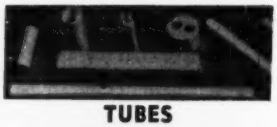
Admittance with this invitation only.

WIRES

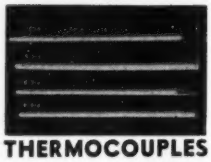


THERMOCOUPLE HEADS

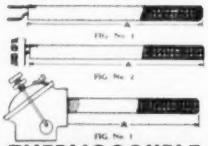
INSULATORS



TUBES



THERMOCOUPLES



THERMOCOUPLE LEAD WIRES

WE OPERATE OUR OWN WIRE INSULATING MILLS

Large supply contracts our specialty. Aircraft temperature wires and cables.

INDUSTRIAL PYROMETER AND SUPPLY Co. ALTON, ILL. U.S.A.

INDUSTRIAL PYROMETER AND SUPPLY COMPANY

ALTON, ILLINOIS

For more information circle **36** on inquiry card.

THE IDEAL SOURCE OF D-C VOLTAGE FROM A-C LINES

VARICELL

STABILIZED and REGULATED

Output voltage is unaffected by changes in the magnitude of a-c line voltage or output load current. Stabilization and regulation is ± 0.25 volts. R.M.S. ripple voltage is less than 0.1 volts.

ADJUSTABLE OUTPUT SETTINGS

Any desired output of d-c voltage from 0 to 30 volts is achieved by simply rotating the handwheel on the front panel.

CONVENIENT, EASY TO USE

The VARICELL is operated by simply plugging into any handy a-c voltage source supplying a nominal 115 volts, 60 cycles, 1 phase. The load is connected to either of the two pairs of SUPERIOR 5-WAY Binding Posts. The assembly is energized by an "On-Off" switch. A voltmeter visually identifies the output voltage at the binding posts. An ammeter shows the output load current.

ENGINEERS, LABORATORY TECHNICIANS, PRODUCTION TEST MEN and ALL OTHERS WORKING WITH LOW D-C VOLTAGES . . . get complete information now on the VARICELL. Use coupon below to get your copy of Bulletin V1051.

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

THE SUPERIOR ELECTRIC COMPANY
708 Mae Avenue, Bristol, Connecticut

Please send my free copy of Bulletin V1051 describing the VARICELL.

NAME_____
POSITION_____
COMPANY_____
CO. ADDRESS_____
CITY_____ ZONE____ STATE_____

For more information circle **37** on inquiry card.

PRECISION FREQUENCIES

ACCURACY: 1 PART IN 100,000 (OR BETTER) .001%

FOR USE IN SUCH FIELDS AS

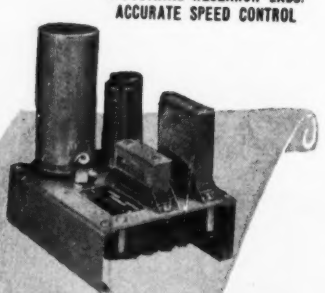
AVIATION
ASTRONOMY
BALLISTICS
HIGH-SPEED PHOTOGRAPHY
VISCOSITY MEASUREMENT
NUCLEAR PHYSICS
TELEMETERING
RADIATION COUNTING
FLUID FLOW
CHEMICAL REACTION
NAVIGATION
SCHOOL LABORATORIES
INDUSTRIAL RESEARCH LABS.
ACCURATE SPEED CONTROL

The controlling unit of these frequency standards is a bi-metallic fork, temperature-compensated and hermetically sealed against humidity and variations in barometric pressure. When combined with related equipment, accurate speed and time controls are afforded by mechanical, electrical, acoustical or optical means.

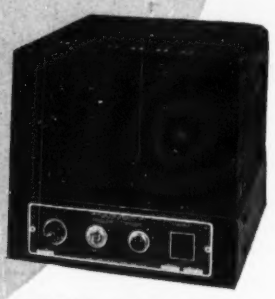
Instruments of our manufacture are used extensively by industry and government departments on such precision work as bomb sights and fire control.

Whatever your frequency problems may be, our engineers are ready to cooperate.

When requesting further details, please specify the Type Numbers on which information is desired.

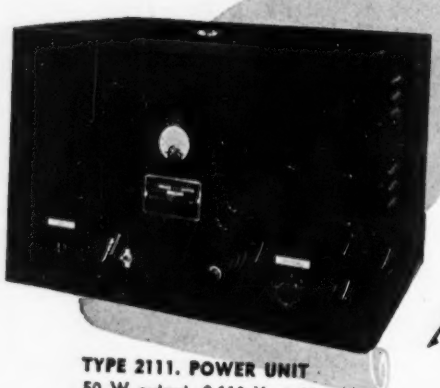


TYPE 2001-2. BASIC UNIT
Frequencies, 200 to 1500 cycles. Dividers and Multipliers available for lower and higher frequencies. Miniaturized and JAN construction. Output, 6 volts.



TYPE 2005. UTILITY UNIT
consists of Type 2001-2 and booster to provide 10 watts at 110 V at 60 cyc. Input, 50-100 cyc.

TYPE 2121A. LAB. STANDARD
Outputs, 60 cycle, 0-110 Volts. 120-240 cycle impulses.
Input, 50-400 cycles, 45 W.



TYPE 2111. POWER UNIT
50 W output. 0-110 V at 60 cyc.
Input, 50-100 cyc., 275 W.

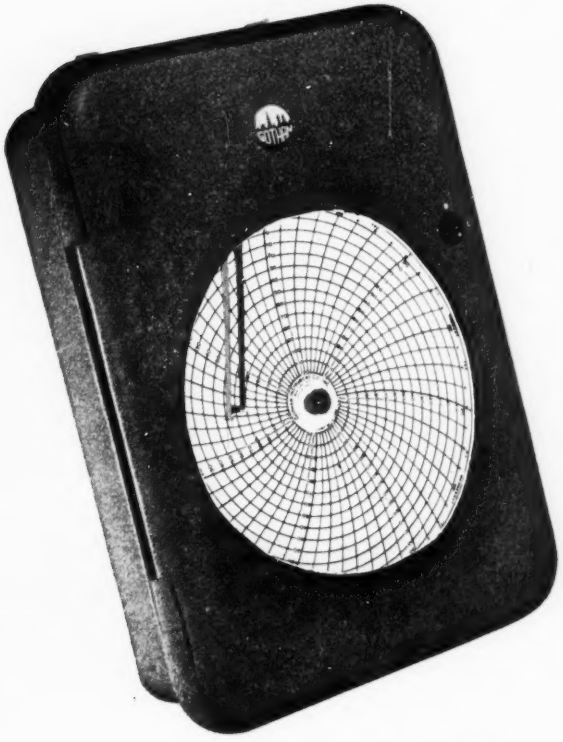
American Time Products, Inc.
580 Fifth Avenue *New York 19, N. Y.*

OPERATING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY

For more information circle 38 on inquiry card.

GOTHAM CONVERTIBLE

grows or changes to fit your needs



Want an instrument that can grow or change to fit your needs—an instrument that is a miser for maintenance and replacement inventory?—Then choose the Gotham Convertible. It is a 1-2-3-4 pen recorder; 14 pressure, temperature and time operation combinations. It is a recorder controller; there are 38 pressure, temperature and time operation combinations.

All components are Gotham standard, factory calibrated systems, completely interchangeable and easily removable or replaceable at the job site.

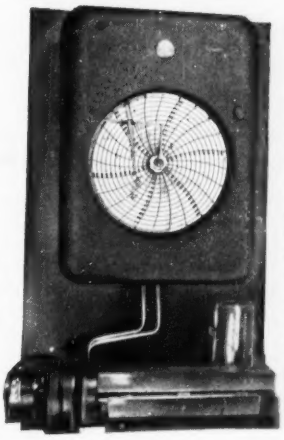
Number of functions possible depends on whether instrument is 6", 9" or 12" chart size.

GOTHAM INSTRUMENTS

Keep everything under control with Gotham

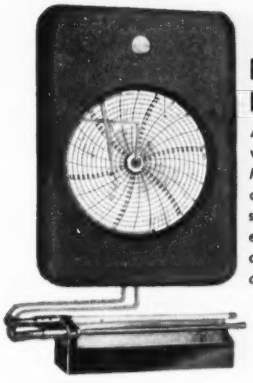
SELF-CONTAINED PORTABLE RECORDER

Here, at last, is a portable recorder built to full-size instrument reliability. Built from Gotham standard elements, interchangeable with other Gotham instruments. 6", 9" and 12" chart sizes. Mercury, Vapor or Pressure Actuated. Spring or electric chart drive. See Catalog 400.



RECORDING PSYCHROMETER

Incorporates highly accurate and responsive thermal systems and many other Gotham standard convertible elements. Wet and dry bulb type. Motor-driven suction fan. 12" chart size. Catalog 400.



RECORDING HYGROMETER

A 2-pen recorder of the wet and dry bulb type. Mercury or Vapor Actuated. 9" and 12" chart sizes. Available with variety of wet and dry bulb assemblies depending on application. Catalog 400.

GOTHAM INSTRUMENTS
Division of American Machine and Metals, Inc.
Dept. 2, 233 Broadway
New York 12, New York

Please send me a copy of your

- ☐ Catalog 100—Industrial Thermometers
- ☐ Catalog 200—Dial Type Thermometers
- ☐ Catalog 400—Recorders, Psychrometers, Hygrometers
- ☐ Catalog 500—Controllers
- ☐ Have your representative call. No obligation.

Name..... Title.....

Company.....

Address.....

City..... Zone..... State.....

For more information circle 39 on inquiry card.

AMERICAN ELECTRONIC PROCESS CONTROL SYSTEM

improves QUALITY of CONTROL

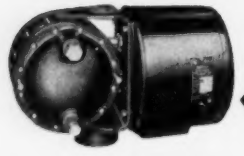
reduces CAPITAL INVESTMENT

Every advantage and superiority of electric transmission of measurement and operational signals is utilized in the new, complete American Electronic Process Control System. Quality of control of temperature, pressure, differential pressure, liquid level and flow is improved. Capital investment for a given through-put is reduced. Ideally suited for integration into automatic logging systems. Every requirement for accuracy, dependability, flexibility, low maintenance and convenient servicing is fully satisfied because this new electronic system provides:

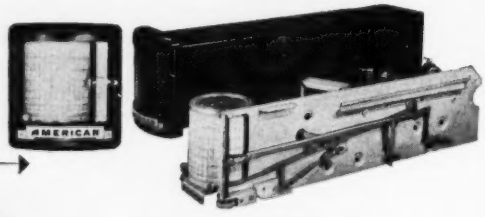
1. Practically lag-free signal transmission.
2. High stability that permits use of narrower proportional bands.
3. Control sensitivity virtually impossible to duplicate in other types of actuation.
4. Freedom from dirt, corrosion, leakage and freeze-ups.
5. Standardized control components interchangeable at the panel.
6. Control-house installed controllers, *any* distance from the process area.
7. Easy-to-service plug-in components in each instrument.
8. Adaptability—more than one input circuit can be fed into a controller for cascading purposes, without adding a relay.
9. Flexibility—output signal can be fed in series to any number of receivers, without impairing accuracy.
10. Transducers for tie-in with pneumatic systems.
11. Minimum capital or maintenance investment in air compressors, filters, pressure regulators or dryers.
12. Integration with analog and digital computational and print-out equipment.
13. Multipoint-potentiometer type recording of all process variables.

Major instruments in the American Electronic Process Control System are pictured here. Get complete data. Learn how this new system can *improve quality of control and reduce the size and cost of your process equipment for a given through-put.*

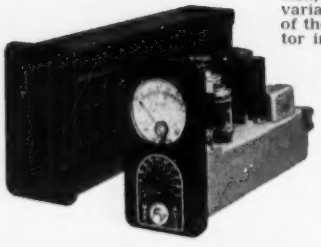
Write for Catalog No. 164.



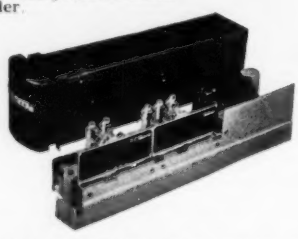
AMERICAN ELECTRONIC TRANSMITTERS. Transmit measurements of temperature, pressure, differential pressure, liquid level and flow. Pictured is differential pressure transmitter with Barton cell.



AMERICAN ELECTRONIC RECORDING CONTROL STATION, TYPE 162. Records the value of process variables and determines the control points of the controller. Type 161 provides indicator instead of recorder.



AMERICAN ELECTRONIC MANUAL POSITIONER, TYPE 153MP. For remote loading of the Electro-Pneumatic Valve Positioner or an Electro-Pneumatic Transducer. Designed for use with Type 163 Controller.



AMERICAN ELECTRONIC CONTROLLER, TYPE 163. Automatically controls the manipulation of a process variable by means of the Electro-Pneumatic Valve Positioner or an Electro-Pneumatic Transducer.

AMERICAN ELECTRO-PNEUMATIC VALVE POSITIONER, TYPE 132C. Provides precise positioning of all standard pneumatically-powered valves by an electric signal. Useable with either air-to-open or air-to-close valves.

AUTOMATIC LOGGING — continual tabulation of process values in digital form by an electric print-out device — is becoming of increasing importance to the economical operation of the process industries. The output of the instruments in the American Electronic Process Control System (0.5 to 5.0 milliamperes) is ideally suited to the input requirements of available automatic logging equipment.

AMERICAN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

For more information circle 40 on inquiry card.

Windpipe for a peaceful H-bomb

You can call it an H-bomb if you like. Some people do. Technically, it *is* a hydrogenation bomb or, simply, a super-pressure vessel. Uses for it are legion but not warlike.

Researchers in rubber, plastics, pharmaceuticals, petroleum, and solvents pilot their hydrogenation, oxo-reaction, polymerization and other jaw-breaker problems in its gizzard—under high pressure.

To speed-up chemical reactions, the vessel is rocked 38 times a minute. Pressurizing a see-sawing chamber is in itself a neat trick: when pressures of the order of 60,000 p.s.i. are required you might become discouraged or concerned.

American Instrument Company, Inc., maker of Super-pressure equipment, introduces the pressure through a spiral windpipe. They had some trouble through tube breakage but that was before they tried Superior 304 Cold-drawn Seamless Stainless Steel Tubing. Superior gives them just the flexibility and fatigue strength needed for cyclic operation, plus chemical resistance and burst pressure to spare. Spirals of Superior 304 are easier to bend, last longer. And American Instrument reports them dimensionally uniform, smooth and free from surface imperfections.

If you haven't found small tubing in the analysis, size, and finish you want, or if you think there's little difference in tubing or tubing experience, Superior invites your inquiry. Superior Tube Company, 1968 Germantown Avenue, Norristown, Pennsylvania.

Round and Shaped Tubing available in Carbon, Alloy, and Stainless Steels; Nickel and Nickel Alloys; Titanium, Zirconium, and Beryllium Copper

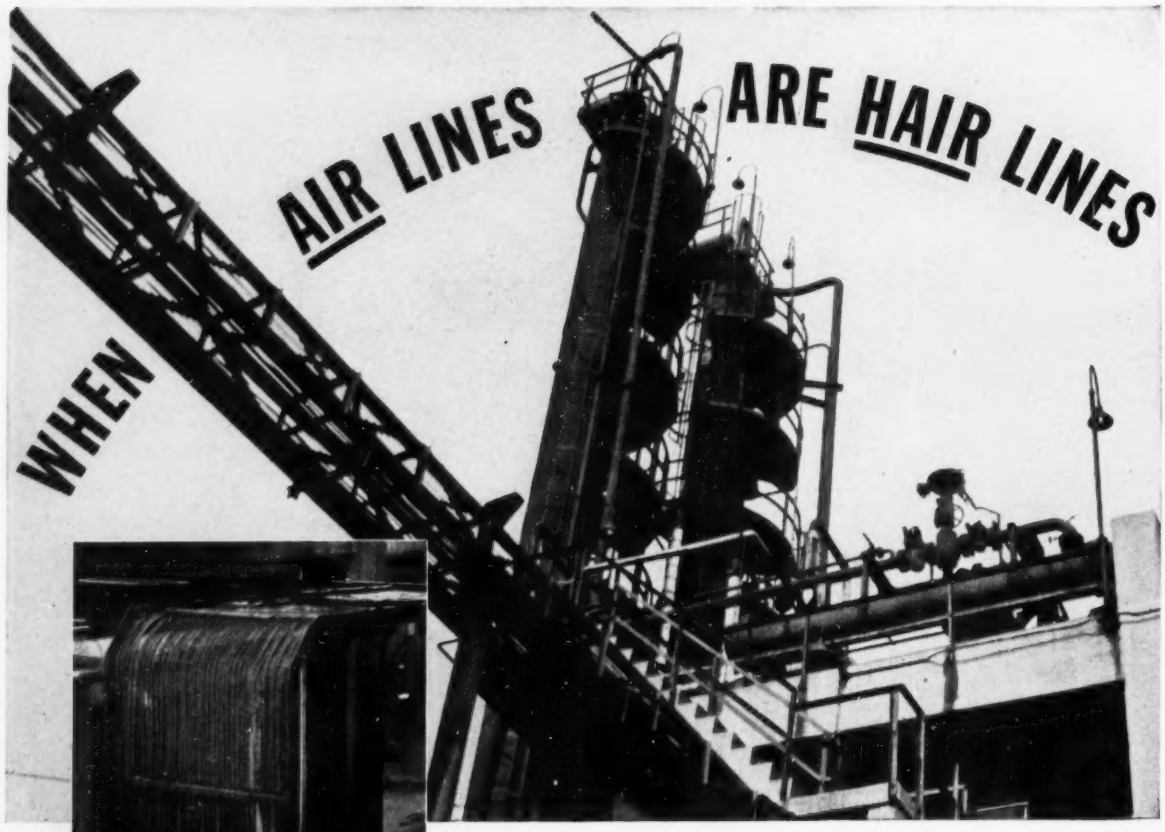
Superior

THE BIG NAME IN SMALL TUBING

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. UNderhill 0-1331

All analyses .010" to ⅝" O.D.
Certain analyses (.035" max. wall) up to 1⅜" O.D.

For more information circle 41 on inquiry card.



Hundreds of these tiny air lines run all over this huge Cleveland refinery, unprotected against freezing temperatures. Instrument air is dried DRY by Lectrodryers.

INSTRUMENT AIR MUST BE DRY AND CLEAN

Moisture turns to ice, blocking air lines. Rust and sludge clog delicate instrument ports, upsetting the delicate controls on which your processes depend. The solution is—

Remove *vaporous* moisture from your air with a Lectrodryer as it comes from the compressor, not just the water which after-coolers, filters and separators catch. Free your air of oil and dirt with a Lectrofilter. These devices are standard equipment today in many refineries, processing and industrial plants whose operations are dependent upon air controls.

Lectrodryers are charged with Activated Alumina, which removes vaporous moisture to dewpoints as low as −110°F. One column is reactivated while the other is at work, a function which goes on year after year without supervision other than throwing a switch every few hours.

You'll save through reduced instrument maintenance and on the initial cost of air lines, and gain dependability simply by DRYing and CLEANing your instrument air with a Lectrodryer and a Lectrofilter. May we advise you on your requirements? Write Pittsburgh Lectrodryer Corporation, 330 32nd Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

FREE BOOKLET

"Because Moisture Isn't Pink" describes Lectrodryers and their application in industry. Write for this booklet today.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

*REGISTERED TRADEMARK U.S. PAT. OFF.

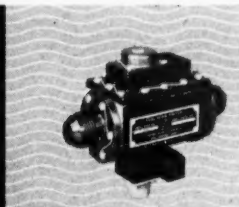
For more information circle 42 on inquiry card.

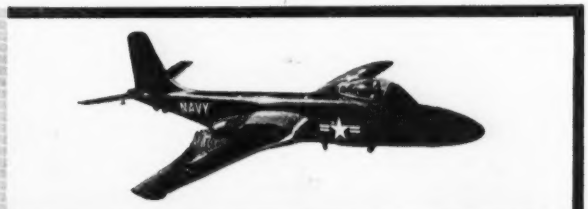
Revere INSTRUMENTS HAVE A RECORD OF TOP PERFORMANCE IN TOP AIRCRAFT

Revere control instruments have shared the responsibility and achievements of the aircraft industry since 1939 with years of dependable performance under all types of weather conditions. Today Revere is recognized as one of the foremost producers of precision instruments. You'll find them installed in many world-famous airplanes.

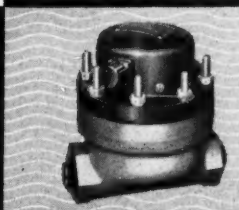
Extensive research and development facilities coupled with precision production methods contribute immeasurably to Revere's reputation for highest quality control instruments. Contact Revere's field engineering department today. Let qualified engineers assist you with your liquid or electro-mechanical control problems . . .

FUEL FLOW SWITCH
Specially designed by Revere for use in the auxiliary fuel line of the McDonnell F2H-3 twin-jet, carrier-based fighter. This instrument transmits a warning signal whenever fuel flow falls below a pre-determined value. *Send for Bulletin No. 1400*

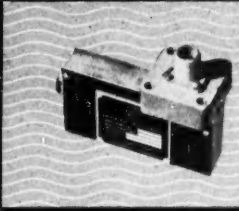


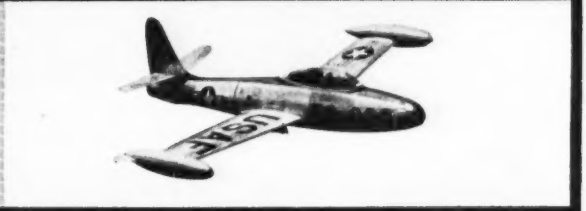


FUEL FLOW TRANSMITTER
The Revere Fuel Flow Totalizer is an integral part of the fuel system. It records the rate of fuel flow in the T-33's jet engines. The flow totalizer can be used on piston engines, diesels or test stand operations. *Send for Bulletin No. 1300*

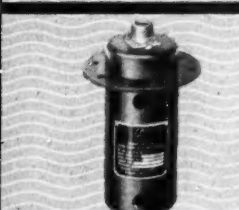


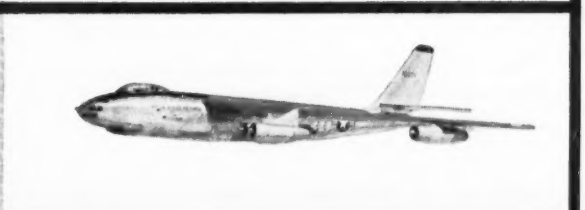
LIQUID LEVEL SWITCH
Republic's F-84G Thunderjet, first USAF fighter-bomber to refuel in mid air, has Revere's Liquid Level Switches installed in their fuel tanks. This hermetically-sealed, magnetically actuated switch presents a new standard of safety. *Send for Bulletin No. 1100*





FLOAT SWITCH
Boeing's B-47 Stratojets have Revere Float switches installed in all fuel tanks to maintain high-level fuel control. These switches can be furnished with single or dual float systems with levels set at the factory. *Send for Bulletin No. 1200*





SEND FOR FREE BULLETINS!

REVERE CORPORATION OF AMERICA

WALLINGFORD 2, CONNECTICUT, U.S.A.

precision instruments for aircraft and industry

For more information circle **43** on inquiry card.

See the ®Nash® Clean Air Compressor at the 1953 American Instrument Fair, Booth 142-143, Chicago, Sept. 21st to 25th

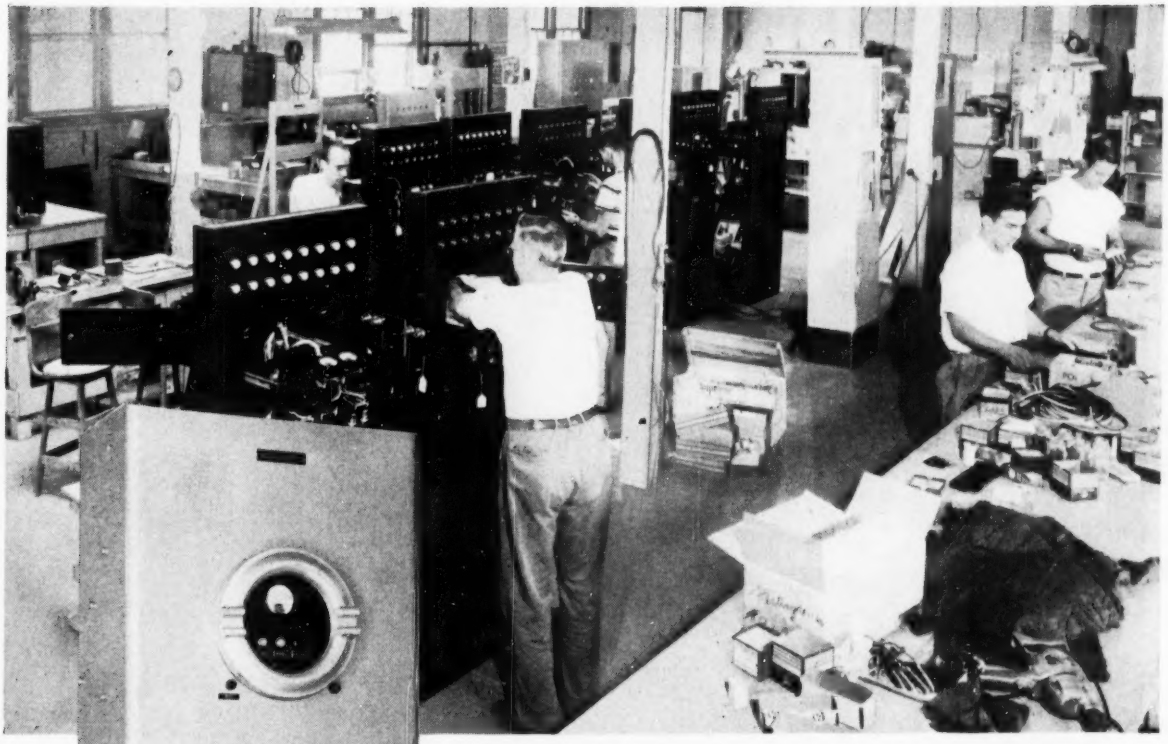
Here is Why!

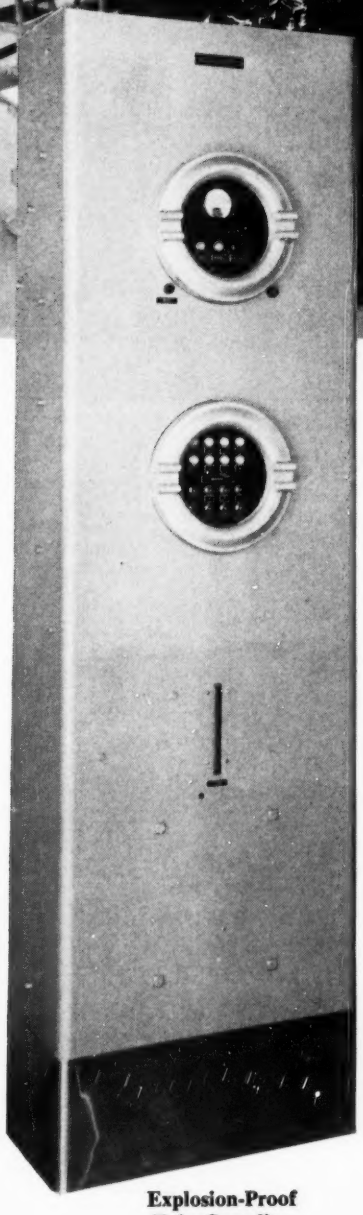
You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

- No oil filters.
- No dust filters.
- No internal lubrication to contaminate air handled.
- No internal wearing parts.
- No valves, pistons, or vanes.
- Non-pulsating pressure.
- Original performance constant over a long pump life.
- Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.





Explosion-Proof Tube Sampling Gas Alarm System

DAVIS GAS ANALYSIS SYSTEMS

FOR EVERY INDUSTRIAL APPLICATION

REMOTE HEAD SYSTEM
Continuous combustible gas analysis, recording and alarm system covering one or many points.

TUBE SAMPLING SYSTEM
Economical protection for 3 to 12 different locations where continuous analysis is not required.

EXPLOSION-PROOF SYSTEM
Alarm systems for Class 1, Group D areas.

SEMI-PORTABLE UNITS
Complete and accurate analysis, with or without alarm and recording features, in a movable housing. Also, hand units.

The Davis line of Gas Analysis and Alarm Systems has been designed to provide industry with dependable, accurate instruments to meet every requirement in protecting lives, property and processes against toxic and explosive gases and vapors. Davis units are tailored and installed to provide maximum performance in each specific application. Literature on the complete line will be sent gladly upon request.

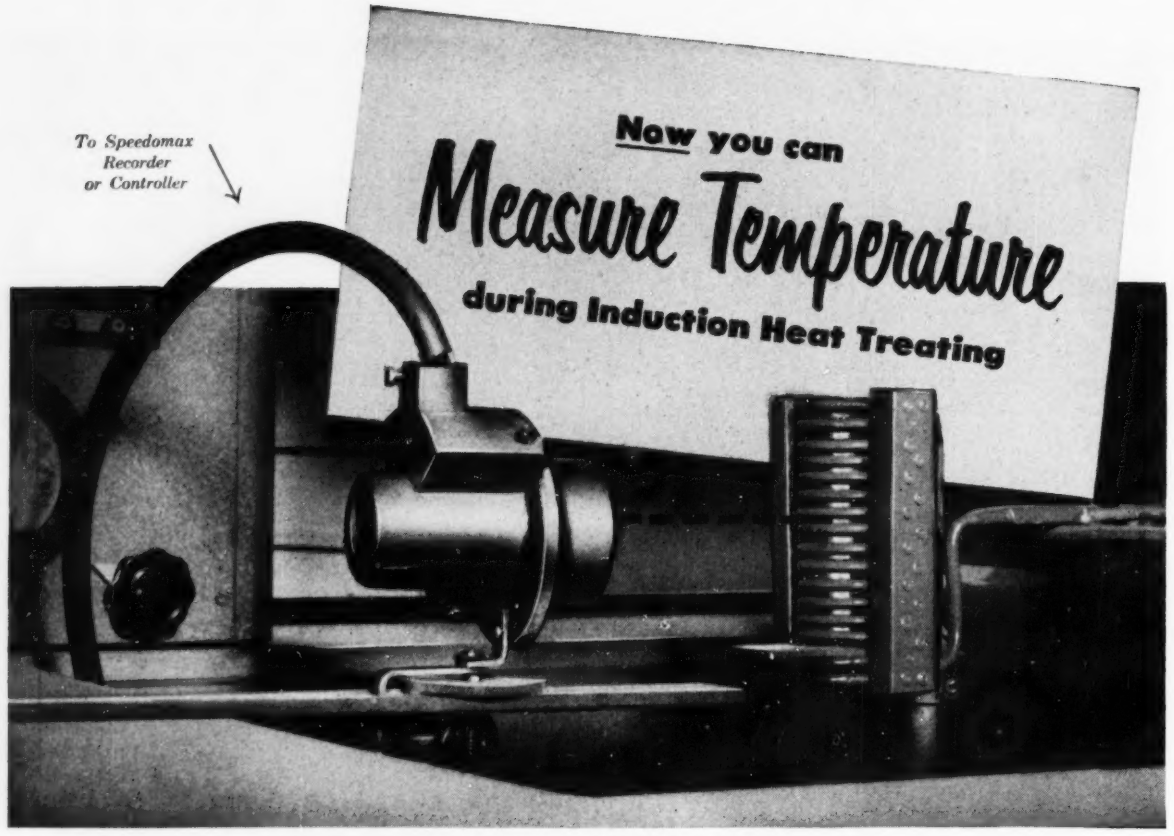
Visit Booths 69 and 70 at the Eight National Instrument Exhibit

DAVIS INSTRUMENTS

Division of DAVIS EMERGENCY EQUIPMENT CO., INC.

80 Halleck Street, Newark 4, N. J.

For more information circle 45 on inquiry card.



In this simplified set-up the Rayotube detector is sighting on steel bar stock between coils of the heating unit. A Speedomax controller connected to the Rayotube automatically regulates and records temperature.

This installation is at Lehigh University where the Dept. of Metallurgy uses a Lepel High Frequency Induction Furnace to investigate the influence of induction heating on the properties of various steels.

With this new Rayotube detector, it is possible for the first time to measure and control temperature of metal parts being heat treated by high frequency induction during their entire cycle.

Mounted only four inches from the induction heating coil, this newest member of the Rayotube family can focus on an opening as small as 0.1 inch between turns of the coil, and through this opening sight on the hot surface of the work. The Rayotube is so fast it reaches 99% of true temperature in 0.6 second . . . is always within 0.15 second of changes in work temperature.

Teamed with a Speedomax instrument it enables you to automatically measure, record and—if desired—control the entire heating cycle directly from the temperature of the work.

If you'd like more details about using Rayotube detectors on high frequency induction heating or similar applications, just write us at 4955 Stenton Avenue, Philadelphia 44, Pa.

SPECIFICATIONS FOR THE SMALL TARGET RAYOTUBE DETECTOR

Catalog Number	8891-C
Response Time	0.15 second to 63% of temperature change; 0.6 second to 99% of temperature change.
Minimum Target Size	0.1 inch at 4 inch focus
Range	1100 F up
Housing Temperature	Can safely withstand 350 F maximum ambient temperature
Optical System	Narrow-angle, double mirror type with visual viewer
Case	Metal, hermetically sealed, including covered leadwire terminal block

LEEDS NORTHRUP
instruments automatic controls • furnaces

For more information circle **46** on inquiry card.

Editorial Comment

Value of Instrumentation to Industry

A talk delivered by Dr. John T. Rettaliata, President of Illinois Institute of Technology, b fore a luncl on meeting of the Instrument Society of America at the Conrad Hilton Hotel, Chicago, Thursday, June 11, 1953.

YOU are leaders of a movement, a movement that is contributing much to industrial progress today and that will contribute still more in the future.

By banding together to advance the science of instrumentation, you gentlemen are ushering in an age tending toward complete automatic control. I'm glad I'm on hand to witness its arrival, for it is a thrilling spectacle and one I probably will like to tell my grandchildren about when they ask me what things were like back in the middle of the century.

One of the things I will be able to tell them for certain is that industries as they will know them could never have come into being without the great strides made in instrumentation in these times.

Use of instruments and automatic controls in industry is contributing immensely to increased efficiency and production. It is playing a large part in making possible the attainment of an ancient goal—that of increasing production without lengthening working hours. It is keeping our living standard the highest in the world while affording us leisure time undreamed of in the past.

More than that, instrumentation is helping our industries keep us strong at a time when strength seems to be the only language some nations of the world understand.

I know that your goals are set high. Accomplishing them will require the cooperative effort of all of you. You manufacturers will have to keep on designing instruments and learning how to apply them in the best possible way; you who use instruments and controls must design your processes in such a manner as to take full advantage of automatic control.

Cooperative efforts of this sort are effective, and American industry needs them.

There still is a great deal for you to do, and I'm sure no one realizes that fact better than you. For example, process designers would very much like better answers to two big questions involving the use of instruments. They ask: (1) "How far can I go in cutting plant construction costs by designing to take full advantage of automatic control?" and (2) "How much can the cost of operating the plant be reduced by such a design?"

Answers to such questions will come slowly and only through diligent effort. But in your Society, you have created the means for finding answers much faster than any of you could individually. You are to be congratulated for having done so. In a competitive economy it is not always easy to recognize the fact that industry-wide problems must be handled from an industry-wide point of view.

In facing that truth and acting on it, you are doing more than advancing the self-interest of individual members of your society. I believe you are doing much to raise the general standard of living in this country and to improve business conditions throughout the world.

In a free economy, progress comes from the interplay of minds, from free expression of independent opinion, from new ideas, and perhaps even from arguments between parties able to argue intelligently by virtue of being connected with the same industry and subjected to the same influences.

Instrumentation feels the pulse of every variable in a plant's operation. It removes the guesswork heretofore prevalent in many areas, and replaces it with immediate and accurate information so vital to efficient performance. It assures the safety of countless complex operations. Hazards to life, limb, and property are reduced by instruments, the silent sentinels continuously on guard. Profitable and safe operation is impossible without adequate instrumentation.

I know you will continue your work of advancing the science of instrumentation and control. Our technological society demands these tools, for they are essential to development of greater production, better quality control, and more extensive research.

At the 8th Annual Instrument Exhibit & Conference
Chicago, Ill., Sept. 21-25

207 instrument manufacturers will offer
309 display booths, presenting

$10,000,000 worth of instruments for measurement, inspection, testing, analysis, computing, and automatic control.

Every engineer, instrument man, and plant executive who wants to keep abreast of modern instrumentation, and who wants to see the tools for the Automatic Factory of Tomorrow, should plan to attend. Drop us a card and we will send you a personal entrance pass to the exhibit.

See page 1200 for technical program; page 1203 for list of exhibits; page 1210 for exhibit floor plan.

Announcement

THE SINGLE MOST IMPORTANT TECHNICAL achievement of our time is the development of nuclear means for production of energy. Instruments Publishing Company is proud to announce the serial publication, starting in the September 1953 *Instruments*, of "Nuclear Reactors for Industry and Research," written by nine outstanding authorities and edited by Dr. E. H. Wakefield of Radiation Counter Laboratories, Inc. This serial will be one of the most important technical publications of the year.

Instruments

CONGRATULATES

Isaac Fern Kinnard

Manager of Engineering
Meter and Instrument Department
General Electric Company
West Lynn 3, Mass.

upon being awarded the 1953

LAMME MEDAL

of the American Institute
of Electrical Engineers

The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1253

PROCESS CONTROL (and not otherwise classified)

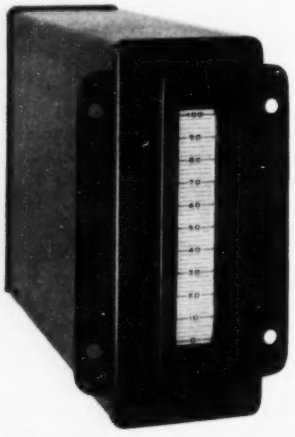
Automatic-control System for Nuclear Reactors

New "packaged" automatic-control system to monitor operation of atomic piles and their related processes comprises a multiplicity of amplifiers, servo-amplifiers, recorders, controllers and servomotors to regulate rate of power generation of nuclear reactors at predetermined levels, by automatically regulating reactor's control rods; also provides automatic safeguards against dangerous operating conditions.—*Industrial Div., Minneapolis- Honeywell Regulator Co., Philadelphia 44, Pa.*

For more information circle **201** on inquiry card.

Indicator for Graphic Panels

New "Model 50 Consotrol Indicator" is a ribbon-type indicating receiver for graphic panel use, especially



suited to panel applications requiring continuous indication of valve position or variable such as liquid level. Pneumatic signal from a transmitter located at process is applied to receiver bellows which, through a lever and stainless-steel tape arrangement, rotates two lightweight drums. A brightly-colored Nylon tape, wound on drums, is drawn behind glass-pane scale: no need of internal illumination. Mechanism can be removed from housing without disturbing scale, case or panel. Instrument is available with single or dual indicating scales; can be adjusted for direct or reverse response to measurement. Alarm contacts optional.—*The Foxboro Co., Foxboro, Mass.*

For more information circle **202** on inquiry card.

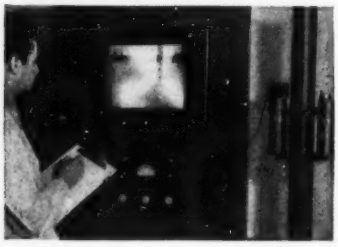
Particle-size-distribution Analyzer

New "Micromerograph" determines particle size distribution of powdered materials; utilizes a technique in which powder particles are dispersed in air and are allowed to settle by gravity through a tube onto a servo-balance, which yields a continuous record of weight of powder settled, plotted against time. Through Stokes' Law, particle-size distribution curve is obtained. Relatively large sample (about 0.1 gm), containing billions of discrete particles, eliminates large statistical errors found in many other methods. Technical skill is not required of operator. A cylinder of compressed nitrogen is required.—*Sharples Corp., Research Laboratories, 424 W. Fourth St., Bridgeport, Penna.*

For more information circle **203** on inquiry card.

Specific-gravity Meter

New "Series SG Specific Gravity Meter" utilizes radioactivity to measure specific gravity of liquids, slur-



ries, sludges or granular materials flowing through pipes. Measurements are made continuously, at operating temperatures and pressures, and generally with no direct contact with process materials and no interference with process. System comprises "Ohmart Cell," "Ohmart Null System of Measurement," "Ohmart Indicating D-c. Amplifier," and any standard single-record potentiometer recorder having a range of 0-20 mv. full-scale. Eight standard ranges from 0.500 to 2.750. Standard primary element fits pipes from 3 in. to 6 in., mounts externally on brackets.—*The Ohmart Corp., 2347 Ferguson Road, Cincinnati 38, Ohio.*

For more information circle **204** on inquiry card.

Alarm Signal Unit

New "Model 400 Tel-A-Unit," designed for condensed panel space requirements, is a self-contained signal

alarm unit utilizing new "Series 100" circuits which permit over 100 variations in circuit sequences by use of same type single unitized hermetically-sealed or general-purpose plug-in units. Horn silencing and lamp-reset pushbuttons are integrally mounted on alarm housing. All circuits can be changed for maintained or momentary N-O or N-C field trouble contact service; many choices of sequences with simple terminal wiring changes. Any number of units may be wired together on one to one power supply and one common horn. Power supply, horn and field trouble contact wiring is grouped in unit terminal housing, ready for service.—*Tigerman Engineering Co., 4332 N. Western, Chicago 18, Ill.*

For more information circle **205** on inquiry card.

Electrophoresis-diffusion Instrument

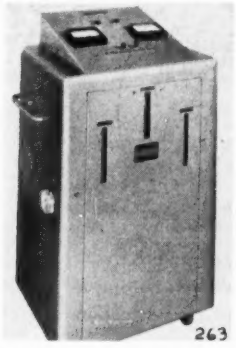
New "Spinco Model H Electrophoresis-Diffusion Instrument," based on a folded figure-4 optical system with an 18-ft. optical path, achieves double sensitivity by directing light through cell and specimen twice; features accessibility of operating controls and

optical elements from observation and recording position. Optics provide versatility in observation and recording of boundaries by five optical techniques: (1) ordinary schlieren, (2) cylindrical-lens schlieren, (3) Rayleigh interference fringes, (4) Gouy fringes, and (5) mechanical scanning. Schlieren and Rayleigh patterns can be recorded simultaneously.—*Specialized Instruments Corp., 655 O'Neill Ave., Belmont, Calif.*

For more information circle 206 on inquiry card.

Gas Analyzer

New "Electro-Conductivity Analyzer" is designed for analysis of gases and vapors which will ionize either directly in water or when de-

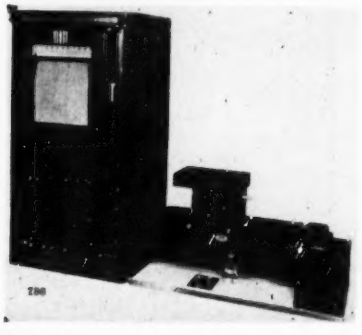


composed by heat. Each instrument is designed to meet individual specifications. Feature is sensitivity to extremely small concentrations. In new analyzer, distilled water passes through reference electrodes, then goes to mixing chamber where sample is mixed with water. After mixing, liquor passes over active electrodes: change in conductivity is proportional to gas present in sample. In low-concentration cases, the water is recirculated and ion exchanges resins are used to remove any ions picked up. —*Davis Emergency Equipment Co., 80 Halleck St., Newark 4, N. J.*

For more information circle 207 on inquiry card.

Recording Spectrophotometer

New "Model RS3" recording spectrophotometer is designed for attachment to Beckman "Model DU" mono-

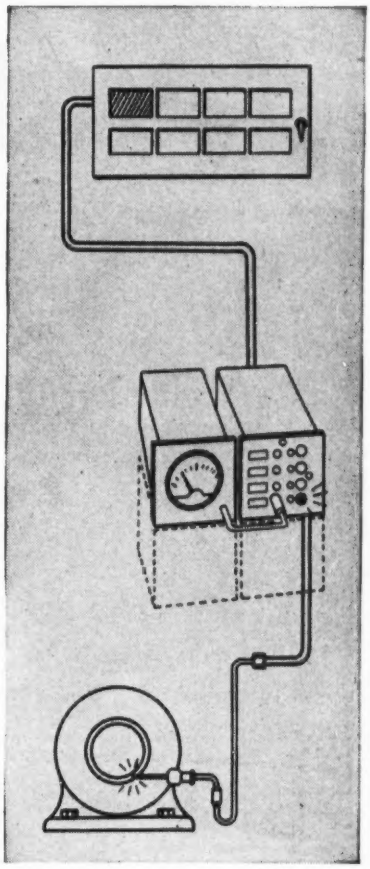


chromator, converts latter to an automatic rapid-recording instrument in ultraviolet and visible regions. Recorder is L&N "Speedomax G" with one-second pen speed for full-scale, and reversible chart drive. Recording

First Showing!

(See it work in Booth No. 28 — Eighth National Instrument Exhibit)

NEW
TEMPERATURE INDICATING & ALARM SYSTEM



A new concept in monitoring. Developed in response to a demand for a system which can be unitized to save control space and allow location of alarm panels close to protected equipment. Designed to give truly economical protection against excessive temperatures found in process industries, power stations, and manufacturing plants. Provides for temperature measurement and overheat alarm in liquids, gases, bearings, etc.

Reduces Installation Costs by 50% or more. Alarm panel units can be grouped as and where needed — close to the protected equipment or in the control room. Resistance thermometers can be installed in practically all types of equipment and require minimum of wiring installation.

Low Equipment Cost. Buy only the number of units you actually need. Add more points later, as required, in form of plug-in units.

One Indicator Serves Multiple Points. Plug-in feature provides direct temperature reading at each position or from control room without requiring compensation for ambient conditions. Spot check of temperature, or continuous observation to determine rate of change.

Each Circuit Independent of Others. Each circuit is "on guard" at all times. No scanning or circuit switching to delay alarm. Warning sounds the instant trouble occurs.

Absolute Dependability. No electronic tubes. Monitors without moving parts. Relay contacts operate only during alarm. Nothing to "wear" out. No adjustments or maintenance to complicate your problem.

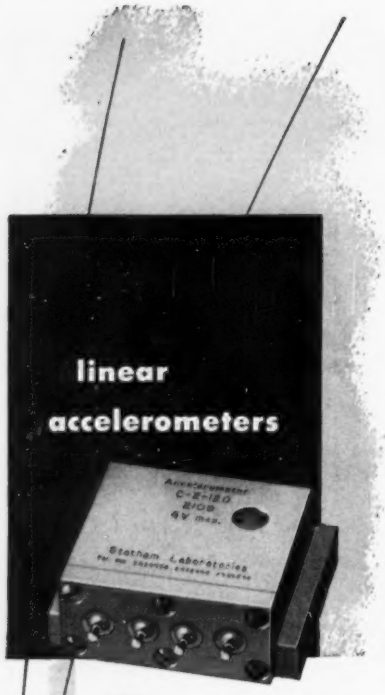
No Personnel Training Required. Alarm light positively identifies trouble point. No switches to operate or leave in wrong position. Personnel are free to perform other duties.

Individual Alarm Setting for Each Point. Individual calibration for alarm temperature is provided. Accessible without removing cover of unit.

Thomas A Edison
INCORPORATED
Instrument Division
24 Lakeside Avenue, West Orange, New Jersey

You Can Always Rely on Edison

For more information circle 47 on inquiry card.



Linear accelerometers are manufactured by Statham Laboratories for measurement in ranges from ±0.5g to ±1,000g. Unbonded strain gage accelerometers have higher natural frequency than is usually attainable with other types of pickoffs. For maximum possible output, the mechanical construction of these instruments is such that movement of the suspended mass produces a change of resistance of all four arms of the complete balanced bridge. The resistive nature of the bridge permits the use of these accelerometers in either A.C. or D.C. circuits.

Please request Bulletin No. 4.0.

Statham LABORATORIES • Los Angeles 64, Calif.

For more information circle 48 on inquiry card.

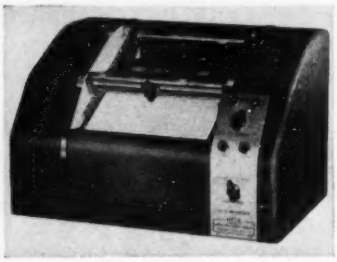
NEW INSTRUMENTS

ranges: horizontal axis includes four scales: 0-100 percent and 0-10 percent absorption, 0-1.0 and 0-0.1 optical density; vertical axis: linear scale 215-700 millimicrons in one continuous uninterrupted sweep. Maximum resolution represents a tenfold improvement on the manual Beckman DU. Sensitivity: percent absorption 0.5 percent or better; optical density 0.002 to 0.005 or better—*Process & Instruments, 60 Greenpoint Ave., Brooklyn 22, N. Y.*

For more information circle 208 on inquiry card.

Letter-size-chart Recorder

New "Data Recorder" does away with errors of reading, computing and plotting (or replotting), by producing test records on 8½ x 11-in. transparent-paper charts, printed with linear or other types of coordinates, with choice of zero-center, side, or suppressed. Control buttons and knobs afford unusual convenience, permit automatic repeat of any desired type cycle, etc. Accuracies as high as 0.1 percent can be obtained. —*Barnes Development Co., 213 W. Baltimore Pike, Landsdowne, Penna.*



For more information circle 209 on inquiry card.

Airborne Tape Recorder

New "NADAR" (North American Data Airborne Recorder) is a lightweight (18-lb.) fire- and crash-proof airborne tape recorder designed to log everything that happens during an airplane or missile flight as long as ten hours: conversations and quantitative data. Tape can be run for another ten hours non-stop with previous information wiped off as new information is recorded.—*North American Aviation, Inc., International Airport, Los Angeles 45, Calif.*

For more information circle 210 on inquiry card.

Industrial Intercom

New "MSA Telecrane FM Carrier Communication System" is a two-way voice communication system for industrial use, linking "base stations" with mobile units such as cranes, ore bridges, yard locomotives and boat unloaders. System is free from transmission noise and interference; employs existing electric circuits for transmitting carrier waves.—*Mine Safety Appliances Co., Pittsburgh 8, Pa.*

For more information circle 211 on inquiry card.

Eight-day Ink Feed

New "Everite Instrument Ink Feed," fabricated of light-weight plastic, is quickly attached with plastic bands to all makes of instrument pens: no brackets or pen-arm alterations. It operates by capillarity: ink feeds first upward, then down to recording point, so sediment never clogs it. Ink flows in right amount only when needed. It uses regular instrument ink and reservoir holds 8 days' supply.—*John P. Squier Co., P. O. Box 6100, Dallas, Texas.*

For more information circle 212 on inquiry card.

Leak-detection Service

New leak detection service is designed for tests of either vacuum or pressure prototypes, development models, pilot models, special laboratory equipment, etc. Service utilizes, in conjunction with maker's "24-101A Leak Detector," a ten-port vacuum manifold capable of testing nine samples simultaneously, comparing leakage to a standard leak of 5×10^{-7} atm. cc./sec. Detected leaks are precisely located, quantitatively measured, and reported.—*Analytical Service, Consolidated Engineering Corp., Pasadena 15, Calif.*

For more information circle 213 on inquiry card.

Nuclear-magnetic-resonance High-resolution Spectrometer

New "Model V-4300 High Resolution Nuclear Magnetic Resonance Spectrometer" permits molecular structures to be determined and components in a mixture identified; can detect differences in NMR structural spectra of isomers (see Fig. 1). High-resolution spectra are observed and either recorded on a strip chart or photographed from an oscilloscope

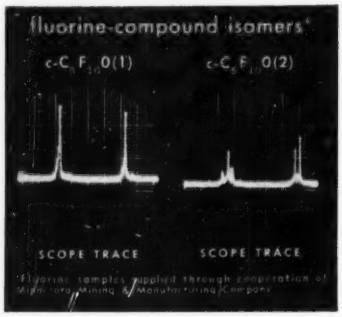
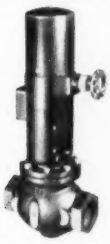


Fig. 1.

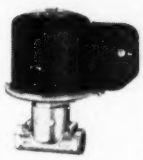
for better automatic controls **GENERAL CONTROLS** *check*

For reliable, automatic control of your product or process . . . whether it is in a heating, refrigeration, industrial or aircraft application . . . General Controls automatic controls will provide dependable, low cost, trouble free performance. Send for a copy of Catalog 53G . . . on your company letterhead, please.

B-55G Governor Type Gas Valve for on-off, high-low modulating and air damper control. Slow opening diaphragm. For gas-flow to industrial boilers and furnaces.



V-110 Electro-Magnetic Valve for gas- and oil-fired boilers. Electro-magnetic trip mechanism prevents flow until current is supplied. Positive safety shutoff.



K-21 Magnetic Stop Valve for liquid and gas. Humless. Coil variations for many temperature and flow requirements. Positive safety shut-off. Valve closes with flow.

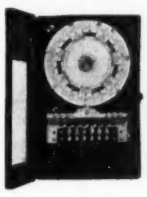
Hydramotor Valve. Screwed type valve body. Fast acting actuator; positive shut-off in ½ to 2 seconds. H-Series actuators available in speeds for every application.

Hydramotor. ac two-wire actuator with specially designed electro-hydraulic pump. Provides reliable normally-open or normally-closed service for gas or fluid control.

Air Motor Valve. Air-opening and closing diaphragm actuators. For modulating control with valve positioners, timers or other instruments for high accuracy flow control.

L-59T Refrigeration Temperature Control. Designed for industrial applications to control magnetic or motor-operated valves, heating or cooling units, relays, etc.

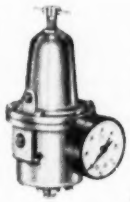
Electronic bridge, signalling type temperature controller. No batteries or moving parts. Excellent performance, high sensitivity with minimum maintenance.



Program Timer, powered by electric or spring-wound clock. Controls daily or weekly operations. Maximum 12 operations a day; 18 minute "off" period.

Pneumatic Indicator in cast aluminum case. Assemblies interchangeable. One of General Controls' wide line of pneumatic indicators, recorders and controllers.

K-15 Magnetic Piloted Piston Valve for gas and liquid control. Large flow capacity, humless and fail-safe. Available in 3 coil, and 5 seat variations.



V-301 and V-302 Pneumatic Pressure Regulators are designed to reduce line pressures up to 150 psi to working pressures of 0-30, 0-60, or 0-100 psi.

K-13 Series 3-Way Packless Magnetic Valves. Solenoid operated, two-wire, current failure type. Designed to control fluids to piston and diaphragm operators.

GENERAL CONTROLS

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Manufacturers of Automatic Pressure, Temperature, Level and Flow Controls for Heating, Home Appliances, Refrigeration, Industrial and Aircraft Applications.

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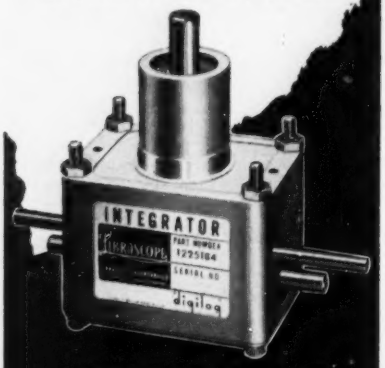
For more information circle **49** on inquiry card.

Ball-Disc Integrator

A small size precision integrating mechanism, the Ball-Disc Integrator. Used for totalizing, rate determination, differential analyzing, closed loop mechanical servo-element, and may be applied as a precision variable speed drive or other applications. High performance and long life are assured by the use of super-finished balls and tungsten carbide disc. Size: Width 1⅝", Length 2¾", Height 3¼", Wt. 21 oz.



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Functional computer components with design emphasis on high performance and simplicity are worthwhile factors to consider when faced with weight, size and reliability restrictions imposed by high precision computer or control problems. Librascope is also well qualified to investigate your particular system needs . . .

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For more information circle 50 on inquiry card.

NEW INSTRUMENTS

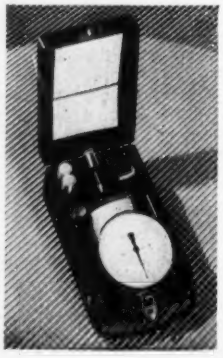
Fig. 2.

screen. Related units utilized include a magnetic field system provided by maker's standard electromagnets, regulated magnet power supplies, and voltage regulator.—*Varian Associates, San Carlos, Calif.*

For more information circle 214 on inquiry card.

Centrifugal Tachometers

New "Type VO" five-range centrifugal-type hand tachometers (Swiss-made) have an improved slip-coupling

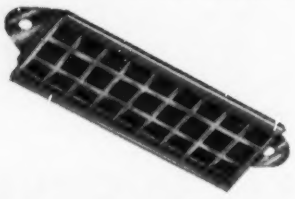


overspeed device which prevents damage from overspeeding on wrong range. Four models with range limits of 30 & 12,000, 45 & 18,000, 60 & 24,000, and 120 & 48,000.—*Herman H. Sticht Co., 27 Park Place, New York 7, N. Y.*

For more information circle 215 on inquiry card.

Static Remover

New "Staticmaster Utility Unit" is not attached to a brush or handle; consists of an extra-powerful strip



of alpha-emitting polonium in a stainless steel housing. Ears at ends of 2.37-in. housing are for convenience in mounting.—*Nuclear Products Co., 10173 E. Rush St., El Monte, Calif.*

For more information circle 216 on inquiry card.

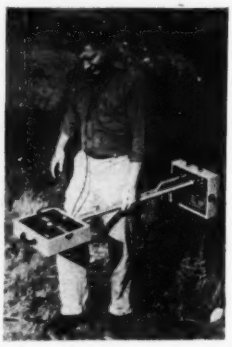
Surveying Instruments with Covered Glass Reticles

New surveying instruments feature covered glass reticles, which permit cleaning of reticles without danger of destroying the fine lines. Any dust which may drop on surface of glass will not be in focal plane of crosslines. There can be no effect of a "spotted" reticle. Cover glass is cemented in place over pattern.—*W. & L. E. Gurley, Troy, N. Y.*

For more information circle 217 on inquiry card.

Metal and Mineral Detector

New "Private Eye" is a portable (10-lb.) detector for locating buried metals and minerals. It uses low-volt-



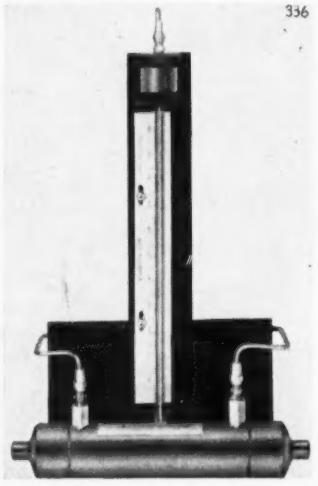
age radio batteries; consists of a transmitter and receiver that may be folded when not in use.—*The Radiac Co., Inc., 489 Fifth Avenue, New York 17, New York.*

For more information circle 218 on inquiry card.

FLOW-RATE and VOLUME

Linear Pressure-drop Gas Flowmeter

New gas flowmeter reads directly in flow-rate units. Its primary element consists of several parallel flow channels, so designed that Reynolds number in each does not exceed 200 at full flow. Thus, differential pressure across a part of length of channel is proportional to volumetric



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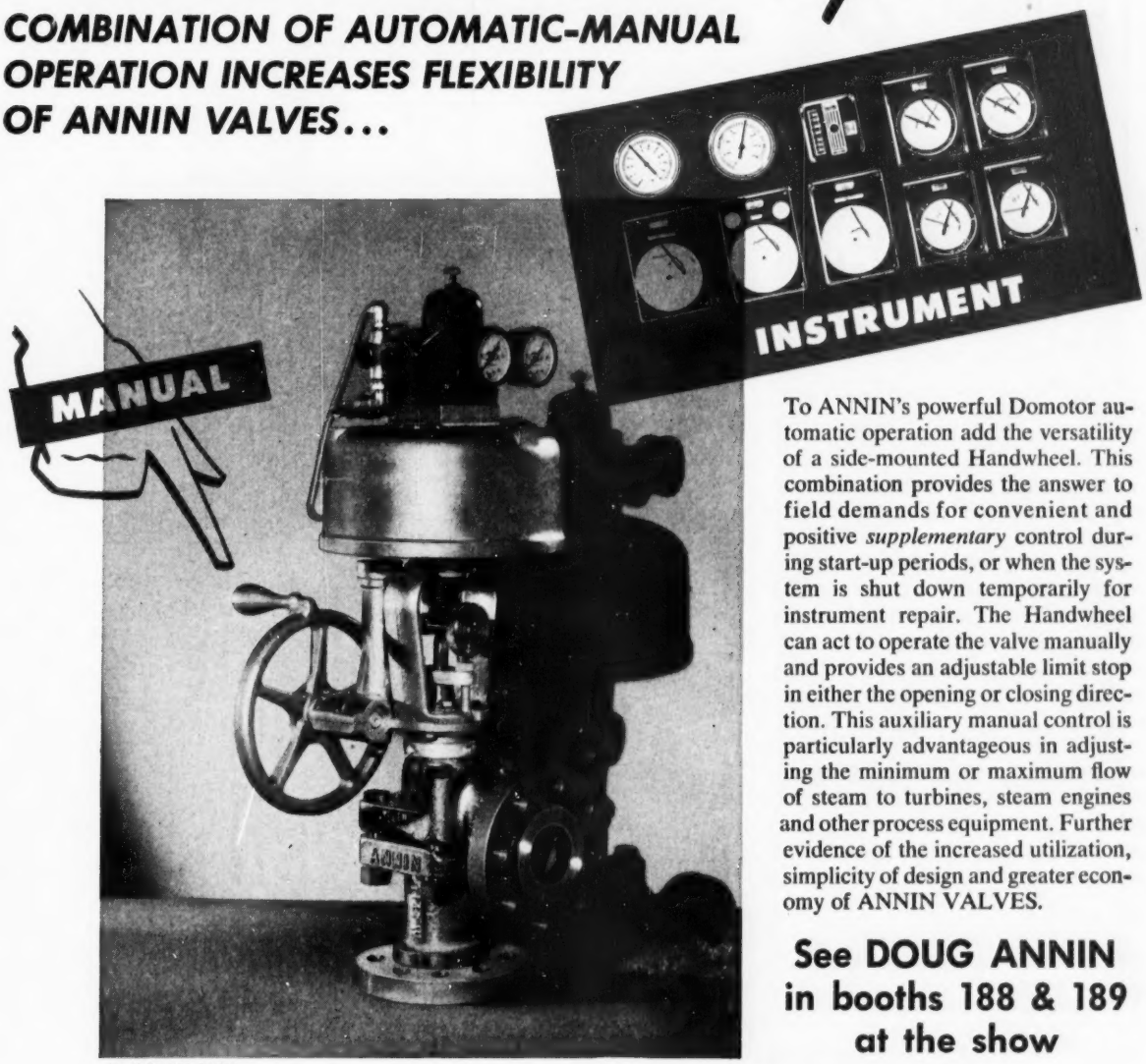
COMBINATION OF AUTOMATIC-MANUAL OPERATION INCREASES FLEXIBILITY OF ANNIN VALVES...



Model 1560 SMW

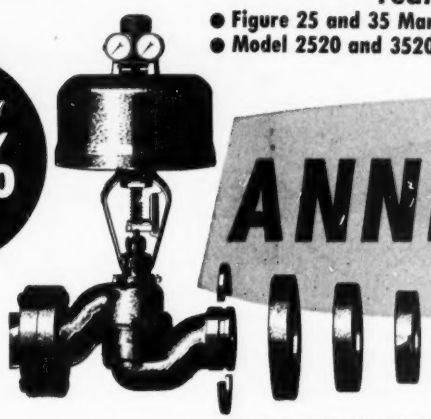
To ANNIN's powerful Domotor automatic operation add the versatility of a side-mounted Handwheel. This combination provides the answer to field demands for convenient and positive *supplementary* control during start-up periods, or when the system is shut down temporarily for instrument repair. The Handwheel can act to operate the valve manually and provides an adjustable limit stop in either the opening or closing direction. This auxiliary manual control is particularly advantageous in adjusting the minimum or maximum flow of steam to turbines, steam engines and other process equipment. Further evidence of the increased utilization, simplicity of design and greater economy of ANNIN VALVES.

See DOUG ANNIN in booths 188 & 189 at the show

Featuring these NEW Annin products:

- **Figure 25 and 35 Manual Valves**
- **Model 2520 and 3520 Cylinder Valves**
- **Model 2560 and 3560 Domoter Valves**
- **Model 5060 Wee Willie Control Valves**

CUT INVENTORY 50% WITH



ANNIN *Control* VALVES

THE ANNIN COMPANY 3500 Union Pacific Avenue
Los Angeles 23, California

For more information circle 51 on inquiry card.

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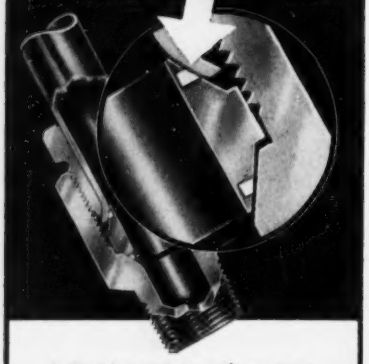
flared-tube fittings
(in Stainless or Monel)
give you the
PATENTED 2-WAY SEAL



1. Double-sealing, self-centering seat is Teflon-reinforced to give you DOUBLE protection against costly, dangerous leaks.
2. Heavy-duty, fatigue-proof . . . designed for high pressure use.
3. Easy to install.
4. Economical . . . parts interchangeable and reusable.
5. Complete line for tubing through 1" O. D.
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Literature covering Koncentrik fittings, and Powell valves with machined-in Koncentrik connections, now available. Write today.

For more information circle 52 on inquiry card.

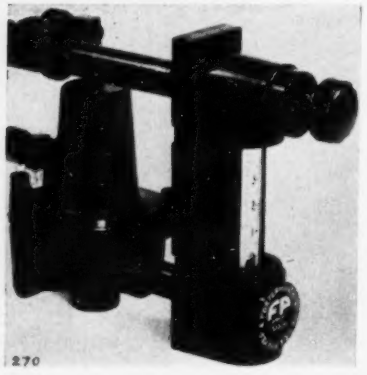
flow-rate and to viscosity of gas. For extreme accuracy under conditions different from calibration conditions, three small corrections must be applied, one of them ordinarily negligible. Among claimed advantages: readings of volume flow independent of density; accuracy down to zero flow; adaptability to simple averaging for pulsating flows: no errors from installation near valves or bends; low pressure drop; ruggedness; flow channels difficult to clog and easy to clean; accurate calibration. Nine standard models, with liquid-column or elastic-element types of indicators, for full-scale flows from 0.003 cfm. to 30 cfm. for most common gases.—*National Instrument Laboratories, Inc.*, 6108 *Rhode Island Ave., Riverdale, Md.*

For more information circle 219 on inquiry card.

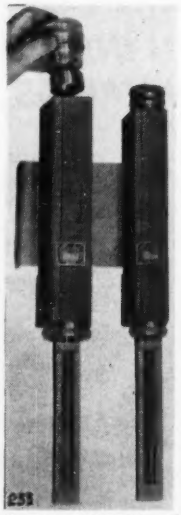
Flow-rate Indicator

New "Purgerator," for metering flows of purge fluids or for liquid level gaging, can be used at pressures up to 300 psi. Various models, each having a 10:1 operating range, are available for flow ranges between 0.05 ml. per min. and 0.65 gpm. of water or between 5 cc. per min. and 0.90 scfm. of air. Among features: (1) horizontal inlet and outlet connections permit meter to be mounted in front of or behind instrument panel; (2) stainless-steel threaded inserts assure leak-resistant connections despite frequent dismounting; (3) precision-bore borosilicate metering tube; (4) can be combined with a pressure differential regulator, as illustrated, for maintaining constant fluid flow rate despite varying downstream pressures.—*Fischer & Porter Co., 14 Jacksonville Road, Hatboro, Pa.*

For more information circle 221 on inquiry card.



Flow-rate Indicators



New models of maker's "Flo-Meters" for measuring flow-rates of air and industrial gases have built-in valves located at top. Cleaning can be completed in less than two minutes. Each unit is calibrated for gas to be measured.—*Waukee Engineering Co., 759 N. Milwaukee St., Milwaukee 2, Wis.*

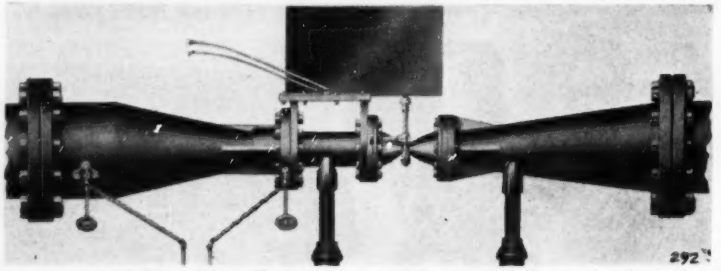
For more information circle 222 on inquiry card.

Air Flow-rate Switch

New "Detect-A-Flo" responds to changes or stoppages in air flow, can also be used as a liquid-level detector or controller since it responds to a change of less than 0.1 in. in liquid level. It can be set to respond to any mass rate of flow of air in approximate range of 1000 to 50,000 lbs. per hr. per sq. ft. (from less than 4 fps. to more than 180 fps. for flows of standard air). It is inserted directly in duct or tank; does not

Automatic Flow-rate Controller for Sludges

New sludge flow-rate controller, of electrical-transmission mechanical type (8-inch diameter squeeze) is designed to control flow of heavily-laden liquids; overcomes most difficulties of regulating heavy viscous flows even if corrosive, without affecting moving parts of controlling mechanism: flexible rubber Venturi-throat section has no pockets or restrictions which could trap particles of putrescent material; can produce complete cut-off if necessary, or wide-open maximum flow.—*Simplex Valve & Meter Co., Philadelphia 42, Pa.*



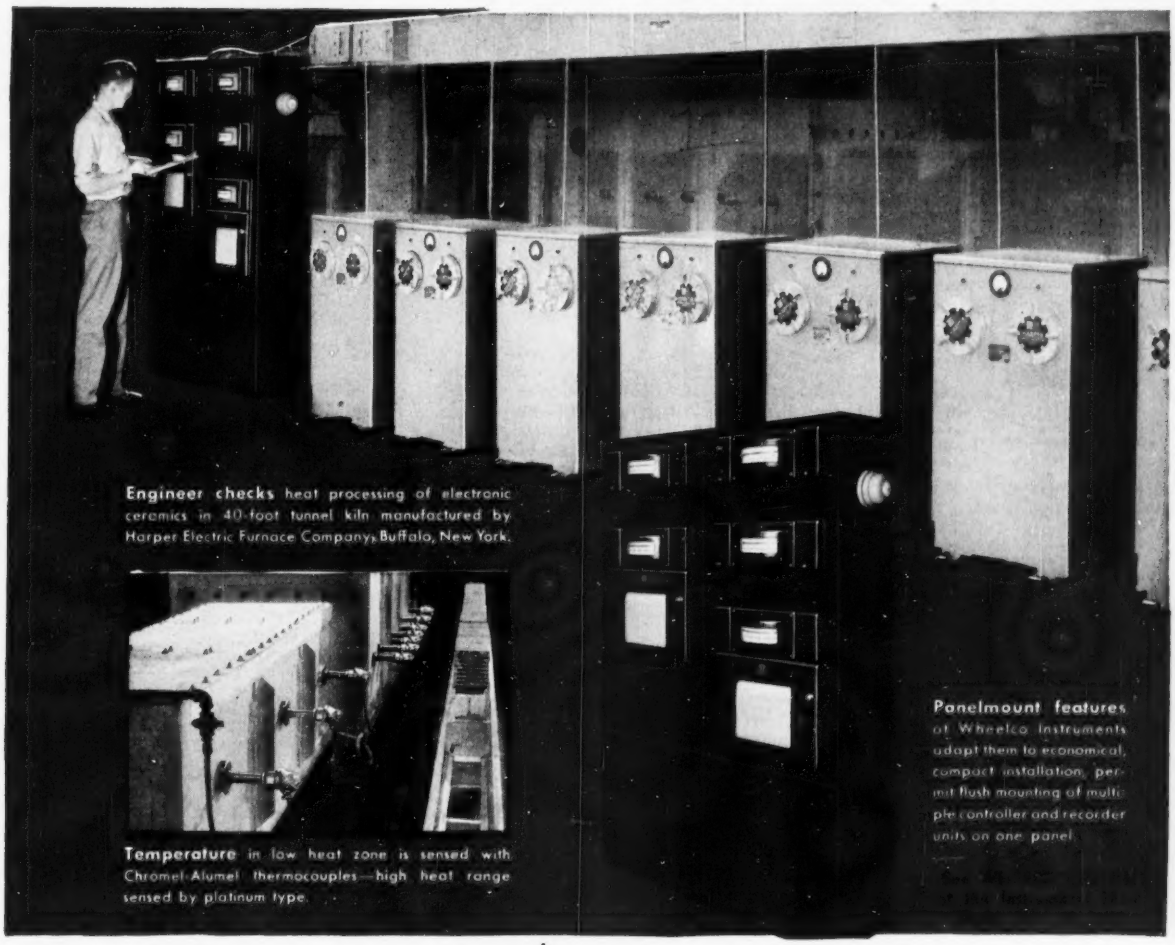
For more information circle 220 on inquiry card.

BARBER COLMAN

Wheelco Instruments

control firing temperatures of ceramic processes at ONONDAGA POTTERY

An important factor in production of high quality miniature electronic resistance circuits and capacitors at Onondaga Pottery Co. is unvarying, precise control over firing temperatures. Wheelco Instruments are used throughout for indicating, controlling and recording critical temperatures of curing ovens and kilns. An example is this new 40' Harper electric tunnel kiln with controlled heating zones. Wheelco Multipoint Capacilogs keep accurate permanent record of temperatures through the entire length of the kiln. Limitrols provide foolproof-protection against overheating. Panelmount Capacitrols give anticipating "straight-line" control of high and low heat ranges. At the central control panel, process engineers get a quick, accurate picture of critical operations at every heating stage! Better consult a Wheelco field engineer on your next process heating job!



Engineer checks heat processing of electronic ceramics in 40-foot tunnel kiln manufactured by Harper Electric Furnace Company, Buffalo, New York.

Temperature in low heat zone is sensed with Chromel-Alumel thermocouples—high heat range sensed by platinum type.

Panelmount features of Wheelco Instruments adapt them to economical, compact installation, permit flush mounting of multiple controller and recorder units on one panel.

Write for Bulletins PC-2, C2-1, LIM-1 and TC-9

Factory-trained field engineers in all principal cities

BARBER-COLMAN COMPANY, ROCKFORD, ILLINOIS

Industrial Instruments • Automatic Controls • Air Distribution Products
Aircraft Controls • Small Motors • OVERdoors and Operators • Molded Products • Metal Cutting Tools • Machine Tools • Textile Machinery

WHEELCO INSTRUMENTS DIVISION
BARBER-COLMAN COMPANY, DEPT. H, 1515 ROCK ST., ROCKFORD, ILLINOIS

Gentlemen: I'm interested in learning more about Wheelco: ☐ Indicators ☐ Controllers ☐ Recorders ☐ Thermocouples. Please send free bulletins.

Name_____

Firm Name_____

Address_____

City_____ State_____

For more information circle 53 on inquiry card.

PALMER

MERCURY ACTUATED
Temperature Indicating
Instruments

4½" DIAL THERMOMETERS

Made in 3 types to suit any requirements. Rigid stem, wall or flush mounted, 11 inches of scale reading. Interchangeable with standard industrial separable sockets. Stem can be placed at any angle and case can be rotated to any readable position.

RECORDING THERMOMETERS

Twelve inch die-cast aluminum case with black or white wrinkle or satin finish. Single or multiple pen construction. Electric or spring wound clock, 24 hour or 7 Day Revolution. Flexible Armor and bulb of stainless steel. Ranges —40 +950°F or Equivalent in °C.

INDUSTRIAL THERMOMETERS

Red-Reading Mercury —Extruded brass case — chrome finish. Ranges —40 + 950°F or Equivalent in °C.

RED-READING MERCURY LABORATORY THERMOMETERS

Thoroughly annealed for permanent accuracy. Complete line A.S.T.M. and fractional division types.

FOR COMPLETE INFORMATION WRITE FOR CATALOG 200 G

PALMER

THERMOMETERS, INC.
Cincinnati 12, Ohio • MElrose 1500

For more information circle 54 on inquiry card.

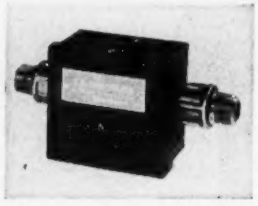
NEW INSTRUMENTS

depend on pressure drop and consequent energy drain on moving stream; is unaffected by vibration; is hermetically sealed. It operates on calorimetric principle: one leg is continuously heated by a small internal heater: as flow-rate drops, heated leg expands because less heat is conducted away; resulting expansion actuates a strut-and-electrical-contact assembly in other leg, breaking circuit. (Action similar to that of maker's "Thermoswitch.") Because of "two-legged" design, unit compensates for changes in ambient temperature. Normal sensitivity is better than 0.25 fps. at low flows and less than 1 fps. at higher flows.—*Fenwal Inc., Ashland, Mass.*

For more information circle 223 on inquiry card.

Magnetically-coupled Flow Switch

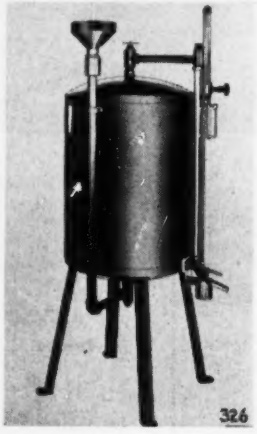
New magnetically-coupled flow-indicating switch is suitable for use with water and other liquids not injurious to brass or copper. Primary flow-rate measuring element is a movable vane within flow tube. A chrome-plated Alnico magnet affixed to vane actuates a switch outside flow tube. Unit has ½-in. I.P.S. brass fittings for direct installation in flow line. Two models, adjustable through 0.1-to-0.6 gpm., and 0.25-to-1.0 gpm., respectively. Unit can be used in lines of greater capacity by installing a by-pass and regulating valve.—*Winterburn Mfg. Co., Putnam, Conn.*



For more information circle 224 on inquiry card.

Constant-rate Liquid Feeder

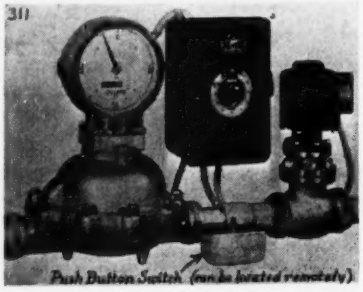
New "Liquifeeder" gravity type liquid feeding device for batch-type processes maintains a constant rate of feed; is adjusted by a valve that meters air admitted to supply tank. Feed can be varied from less than 0.5 pint a day to more than 500 gallons a day. Each unit includes a combination sight glass and bubble type flow-rate indicator.—*Hankison Corp., 352 Biltmore Bldg., 951 Banksville Rd., Pittsburgh 16, Pa.*



For more information circle 225 on inquiry card.

Automatic Preset-volume Liquid-dispensing System

New "Electrivolume Metering System" is an automatic repetitive push-button system of liquid measurement and dispensing. An "Electricontact" meter, designed for particular liquid, transmits an impulse for each volumetric unit; an impulse counter accumulates impulses to preset number; a solenoid valve closes at desired point and counter recycles itself back to zero for next run. An electrically-driven integrator may be located at a distance.—*Buffalo Meter Co., Buffalo 14, N. Y.*

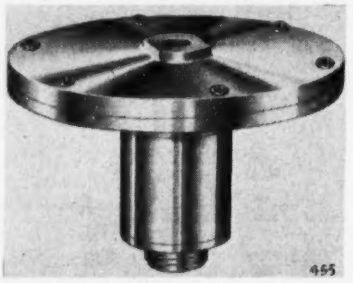


For more information circle 226 on inquiry card.

PRESSURE, LOAD AND FORCE

Pressure Pickup

New "Model P 97 Pressure Transducer," for differential or gage pressures in 0-0.05-psi. range, delivers 3.5 mv. per volt full-scale open circuit, thus being capable of operating many commercially-available indicating, recording and controlling instruments. Natural frequency 350 cps.; resolution 0.1 percent or better; accuracy and linearity 1 percent or better.—*Statham Laboratories, Inc., 12401 W. Olympic Blvd., Los Angeles 64, Calif.*



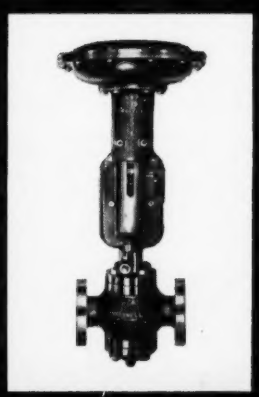
For more information circle 227 on inquiry card.

Heavy-duty Pressure Switch

New "Model 9612" heavy-duty pressure switch has set-point range from 15 to 3000 psi., for actuating circuit on increasing or decreasing pressure. Proof pressure to 7,000 psi. Piston-

For more information circle 55 on inquiry card. →

• for safe, easy stem lubrication



The isolating valve in the stem lubricator of the Honeywell Series 700 Valve affords maximum safety against leakage when replenishing stem lubricant . . . tight-fitting conical plug and machined seat assure leakless shut-off . . . pinned bonnet prevents accidental removal. The Honeywell Series 700 wide band proportional valve comes in a full range of styles and sizes . . . has *all* the features you look for in a fine valve. Write today for your copy of Bulletin 700-2.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 1908 Windrim Avenue, Philadelphia 44, Pa.

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Honeywell
VALVE PRODUCTS

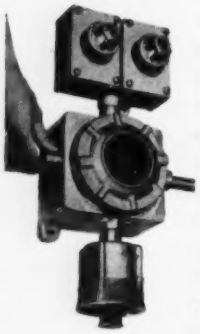
First in Controls

DETECT combustible GAS

INDICATE • RECORD • CONTROL

MODEL F

J-W Model F Indicator checks the presence of combustible gas at inaccessible locations. Aspirator bulb draws air mixture through sampling hose and probe. Meter registers combustibility instantly. Fully portable, dry-cell operated.



MODEL EE

J-W Models E and EE Alarms monitor fixed installations where explosive hazards may exist. For continuous operation from standard 115-v a-c line. Actuate audible or visual signals, control valves or motors. Model EE is explosion proof. Model E is for installation remote from sensing unit.

SENTINEL

J-W Sentinel Alarm serves as a fire-danger watch-dog under conditions of special localized combustible-gas hazard—such as: welding, electrical work, tank cleaning, etc. Storage-battery operated, inbuilt charger, penetrating audible alarm.

Other models available for laboratory, oil-well logging, and other specialized uses. Your inquiry is invited on designs to meet particular requirements.

Standard for over 25 years

Write for complete information

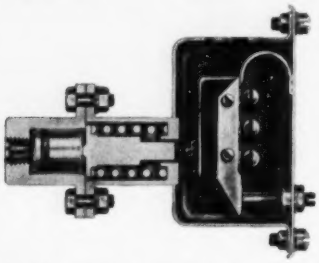
JOHNSON-WILLIAMS, Ltd.

PALO ALTO 3, CALIFORNIA

For more information circle 56 on inquiry card.

NEW INSTRUMENTS

type pressure-measuring element is suitable for applications where millions of cycles are expected. Feature is flexibility of application: basic

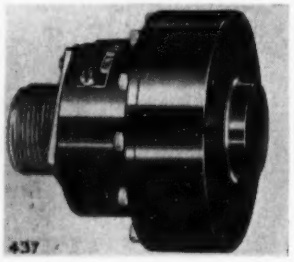


body kit may be converted to changing service requirements by means of interchangeable fitting kits; switch may be mounted in any position; is not sensitive to vibration or line surges—*Barksdale Valves*, 5125 *Alcoa, Ave., Los Angeles* 58, *Calif.*

For more information circle 228 on inquiry card.

Pressure Switch

New "Model 44517" pressure switch, 2.5 in. OD; is set at factory to operate at any differential pressure be-



tween 10 and 200 psi.; will operate at ambient temperatures from —54 to 71 C. and under 0.032-in. double amplitude vibration from 10 to 55 cps. Rating 5 amps. at 125 or 250 v.ac. and 3 amps. inductive motor load at 30 v.dc. sea level.—*G. M. Giannini & Co., Inc., P. O. Box N, Pasadena* 1, *Calif.*

For more information circle 229 on inquiry card.

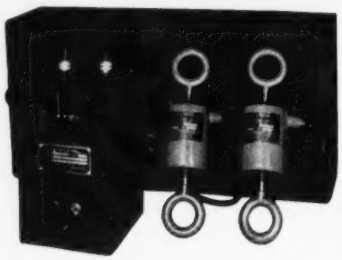
Pressure Switch

New "Series 100 Precision High Pressure Switch" is suitable for pressures from 3 to 3000 psi.; is externally adjustable over this entire range. Electric circuit is s-p. or d-p. Micro Switch, 15 amps., 125 to 460 volts.—*Switch Div., Alloy Bellows Engineering Co.*, 18125 *Roseland Road, Cleveland* 12, *Ohio.*

For more information circle 230 on inquiry card.

Crane Scale

New "Model 116 Electronic Crane Scale" indicates weight on a four-digit counter; weighs while transporting. System comprises load cell attached to hook, control cabinet on crane, and a small indicator attached to pendant control. Operator can eas-

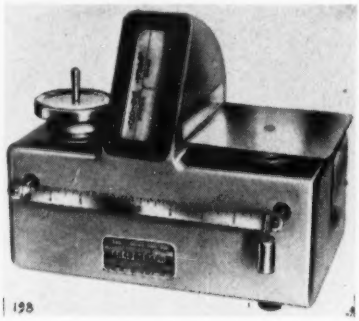


ily tare out chains, hooks, slings, etc. System can be mounted on any size monorail or floor-operated crane.—*Gilmore Industries*, 5511 *Euclid Ave., Cleveland* 3, *Ohio.*

For more information circle 231 on inquiry card.

Over-and-under Scale

New "4200 Series" of maker's "Shadowgraph" scales is a newly-designed center-tower type. Beam and poise are mounted conveniently on

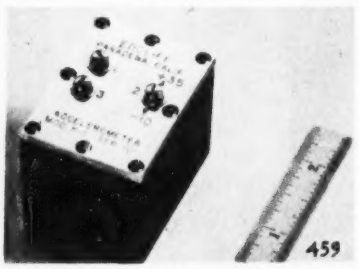


front of scale: beam and indicator dial in direct line with operator's vision. Available in capacities from 50 grams (sensitivity 12 milligrams) to 1500 grams (sensitivity 350 milligrams), also avoirdupois.—*The Exact Weight Scale Co., Columbus, Ohio.*

For more information circle 232 on inquiry card.

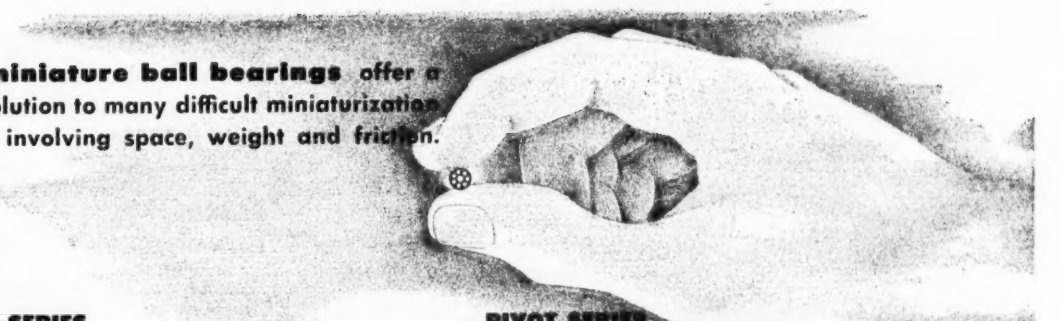
Accelerometer Pickup

New "Model K-1 Linear Accelerometer" is available in standard ranges from plus-and-minus 2 *G* to plus-and-minus 20 *G* with undamped natural



frequencies of 8 to 37 cps. (higher ranges special). Standard viscous damping 0.5 to 0.7 of critical at 25 C. (special 0.2 to critical over range of —40 C. to 70 C.). Perpendicular error is less than 1 percent. Resistor is 5000

MPB miniature ball bearings offer a ready solution to many difficult miniaturization projects involving space, weight and friction.



RADIAL SERIES

BEARING NUMBER	O.D.	BORE	WIDTH
100	.1000″	.0250″	.0312″
2	.1250″	.0400″	.0469″
2½	.15625″	.0469″	.0625″
3	.1875″	.0550″	.0781″
▼4	.2500″	.0781″	.0938″
▼5	.3125″	.09375″	.1094″

PIVOT SERIES

BEARING NUMBER	O.D.	BORE	WIDTH
1½ P	.0590″	.020″†	.0472″
3 P	.1181″	.030″†	.0709″
4 P	.1575″	.040″†	.0945″
▼5 P	.1968″	.050″†	.1181″
▼7½ P	.2953″	.075″†	.1772″
▼10 P	.3937″	.100″†	.2362″

SUPER-LIGHT RADIAL SERIES

418	.2500″	.1250″	.0938″
▼518	.3125″	.1250″	.1094″
5532	.3125″	.15625″	.1094″
5632	.3125″	.1875″	.1094″
5732	.3125″	.21875″	.1094″
614	.3750″	.2500″	.1250″

GROOVED RADIAL SERIES *(Full Race or Retainer Type)*

3 G	3 GC	.2188″	.0550″	.0781″
4 G	4 GC	.2812″	.0781″	.0938″
5 G	5 GC	.3438″	.09375″	.1094″
518 G	518 GC	.3438″	.1250″	.1094″
5532 G	5532 GC	.3438″	.15625″	.1094″
5632 G	5632 GC	.3438″	.1875″	.1094″

FLANGED RADIAL SERIES *(Full Race or Retainer Type)*

2½ F	2½ FC	.15625″	.0469″	.0625″
3 F	3 FC	.1875″	.0550″	.0781″
4 F	4 FC	.2500″	.0781″	.0938″
5 F	5 FC	.3125″	.09375′	.1094″
418 F	418 FC	.2500″	.1250″	.0938″
518 F	518 FC	.3125″	.1250″	.1094″
5532 F	5532 FC	.3125″	.15625″	.1094″
5632 F	5632 FC	.3125″	.1875″	.1094″

RADIAL RETAINER SERIES

2½ C	.15625″	.0469″	.0625″
3 C	.1875″	.0550″	.0781″
4 C	.2500″	.0781″	.0938″
5 C	.3125″	.09375″	.1094″
418 C	.2500″	.1250″	.0938″
518 C	.3125″	.1250″	.1094″
5532 C	.3125″	.15625″	.1094″
5632 C	.3125″	.1875″	.1094″

ANGULAR CONTACT SERIES

2 A	.1250″	.042†	.0469″
3 A	.1875″	.062†	.0700″
▼4 A	.2500″	.085†	.0938″
▼6 A	.3750″	.124†	.1406″
6 A7B	.3750″	.150†	.1406″

THRUST SERIES

2 T	.1250″‡	.0400″§	.0625″
4 T	.2500″‡	.0938″§	.0938″
5 T	.3125″‡	.1250″§	.1250″
6 T	.3750″‡	.1875″§	.1500″
7 T	.4375″‡	.1250″§	.1875″

SPRING SEPARATOR SERIES

5 S	.3125″	.09375″	.1094″
518 S	.3125″	.1250″	.1094″
5532 S	.3125″	.15625″	.1094″
5632 S	.3125″	.1875″	.1094″

SEPARABLE SERIES

3 M	.1875″	.0550″	.0781″
4 M	.2500″	.0781″	.0938″
5 M	.3125″	.09375″	.1094″
518 M	.3125″	.1250″	.1094″

Prefixes indicate material: Standard is chrome bearing steel (SAE 52100): use no prefix. All bearings also available in 440 stainless, except #100 and #1½P. Use prefix "SS" in ordering stainless. ▼Indicates also available in 25 beryllium. Order with prefix "NM". Suffixes indicate type of bearing: F—flange, G—groove, M—separable, C—radial retainer, S—spring separator, T—thrust, P—pivot, A—angular contact, FC—flanged with retainer, GC—grooved with retainer. Complete load ratings are given in catalog. †Shaft (S) min.; ‡ O.D. clearance of opposite race .002″; §Bore clearance of opposite race .002″.

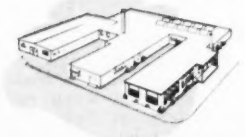
MPB ball bearings

are available in ten design series and in more than 140 different types and sizes which normally can be supplied from stock for prompt installation.

Instrument manufacturers and users of small precision mechanisms can now utilize all the well known extra advantages of anti-friction bearings (accurate alignment, long wear, freedom from attention) universally accepted in larger quality equipment.

For more than 20 years **MPB** ball bearings have contributed to the successful operation of precision mechanisms. A pioneer in designs and dimensions now being internationally standardized, **MPB** has also originated many precision manufacturing techniques. All **MPB** ball bearings are ground, lapped, honed and/or burnished in accordance with highest quality practice for optimum operating characteristics. Inspection limit tolerances are equal to ABEC 5 or better.

The most extensive engineering knowledge in miniature bearing applications is available to you. More than a million **MPB** ball bearings have been installed in precision mechanisms. Catalog 53 giving complete specifications, and additional data sheets mailed to you on request.



Miniature *Precision* Bearings

Incorporated Keene, New Hampshire

"Pioneer Precisionists to the World's Foremost Instrument Manufacturers"

save space weight friction

For more information circle **57** on inquiry card.

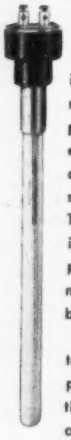
1 QUALITY
2 ACCURACY
3 CRAFTSMANSHIP

all three available in

GORDON

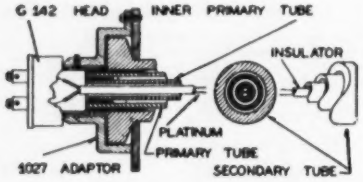
Platinum, Platinum-Rhodium

THERMOCOUPLES



A background of many years of experience and "know-how" go into the production of Gordon Platinum, Platinum-Rhodium Thermocouples. From this experience has evolved the Gordon policy which calls for the utmost in quality and service, the utmost in value to clients. That is why Gordon platinum wire is carefully checked for thermocouple accuracy against a master thermocouple... calibrated and certified by the National Bureau of Standards.

The porcelain insulation and protecting tubes which go into a complete thermocouple assembly are of the finest quality obtainable. They are the best known means of preventing contamination of the elements which result in false e.m.f. values. Also, the Gordon G-142 head which goes



into a complete thermocouple assembly is light in weight and permits easy replacement of new elements into a protecting tube assembly.

The Gordon Policy—highest quality and standards of material — plus Gordon craftsmanship at the lowest possible price.

Write now for full information and price list.

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Thermocouple Supplies • Industrial Furnaces & Ovens
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Dept. 21 • 3000 South Wallace St., Chicago 16, Ill.
Dept. 21 • 2035 Hamilton Ave., Cleveland 14, Ohio

For more information circle 58 on inquiry card.

NEW INSTRUMENTS

ohms with 1 percent linearity and resolution of 300 electrical steps.—*Edcliff Instruments, 383 N. Foothill Blvd., Pasadena 8, Calif.*

For more information circle 233 on inquiry card.

TEMPERATURE

Temperature Controllers

New "Model 221C Capacitrol" indicating controller, added to "Model 200" line, has anticipating action of

"Capaciline" added to "Electronic Link." Also available at this time are four additional "Model 200" series "Capacitrols," two for regular on-off control and two for proportioning control. These, added to "Capaciline-Capacitrols," are said to give a complete range of instruments for every type of process heat control.—*Wheelco Instruments Div., Barber-Colman Co., Rockford, Ill.*

For more information circle 234 on inquiry card.

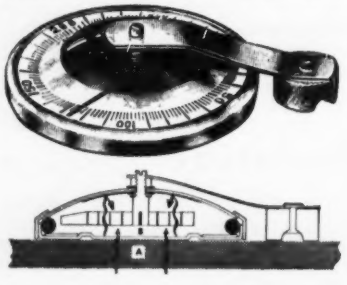
Thermostat for Air-conditioned Buildings

New "T-70H" thermostat has dual purpose of controlling air-conditioned temperatures in summer as well as warmth in winter; has a three-position switch with "off," "heat," and "cool" settings. It obviates need for separate thermostats, and reduces installation costs with a four-wire low-voltage thermostat cable which connects with both heating and cooling controls.—*General Controls Co., Glendale, Calif.*

For more information circle 235 on inquiry card.

Surface Temperature Thermometers

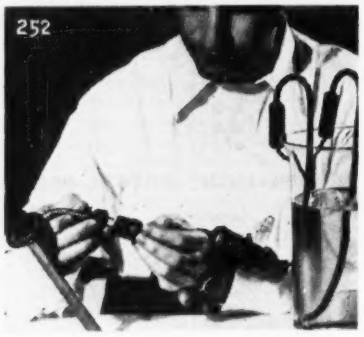
New models of maker's surface temperature thermometers are announced: "Model 311F" from 75 F. to 375 F. and "Model 311C" from 25 C. to 190 C., each graduated in (and with accuracy of) 2-deg. divisions. Thermodynamic design produces an essentially unilateral instrument responding to temperature changes from its back only.—*Pacific Transducer Corp., 11921 W. Pico Blvd., Los Angeles 64, Calif.*



For more information circle 236 on inquiry card.

Quick-connect Thermostats

New thermostat with quick-disconnect plug makes it possible to reduce number of thermostats needed in a



laboratory: no need of one thermostat for each heated device. Thermostat may be used with equal accuracy in a liquid, gaseous, or solid medium, can be adjusted to control over a 500 F. range; heavy-duty models handle loads up to 25 amp. at 110 v. ac. or equivalent.—*Fenwal Inc., Ashland, Mass.*

For more information circle 237 on inquiry card.

Thermoregulator

New "Rota-Set" thermoregulator, for temperature control in water baths, constant-temperature rooms, etc., has magnetic type of setting collar for adjusting temperatures between −10 C. and 110 C. Adjustable tungsten contact moves when magnetic collar is turned. Over-all length 14 in.—*Labline, Inc., 217 N. Desplaines St., Chicago 6, Ill.*

For more information circle 238 on inquiry card.

Parallel Smoke Detector and Fire Detector System

New two-stage smoke detection unit, which can discriminate between light and serious smoke conditions, is combined with a fire detector which will immediately operate a parallel circuit in case a fire or overheat condition occurs that does not generate enough smoke to operate the smoke detector. Smoke detection unit, consisting of a light source and an electric-eye receiver, operates when receiver detects a drop in light intensity such as might be caused by smoke drifting through light beam. Depending on smoke density, receiver

SAVE 36% on Installation Time and Cost

with IMPERIAL Hi-Duty® TUBE FITTINGS

Furnished in Brass, Aluminum, Steel and Stainless Steel

Just Push Tube Into Fitting Without Removing Nut

The sleeve on Hi-Duty Fittings shears off during assembly and becomes permanently attached to tube. Fitting will make repeated tight reconnections.

For Tubing ⅛" to ¾" O.D.

Ask for Bulletin No. 3002

Compared to COMPRESSION FITTINGS

Repeated, thorough tests under field conditions reveal that Imperial Hi-Duty Fittings can be assembled in an average time of 13.2 seconds . . . whereas regular compression type fittings take an average of *20.8* seconds. This is a *36%* saving in time . . . and precious labor.

Compared to FLARED FITTINGS

Here the savings in time are even more striking since it takes *45* seconds on the average to install a flare fitting compared to 13.2 for Hi-Duty . . . a saving of *71%* in time. A man can assemble better than *3* Hi-Duty Fittings in the time it takes to assemble 1 flare fitting.

Why is the HI-DUTY FITTING so much Easier and Quicker to Assemble?

Fitting furnished with integrated nut and sleeve

To get a tight joint, simply insert tube into fitting and tighten nut. No loose sleeve to drop . . . no flaring required. Makes repeated tight reconnections.

MAKES STRONGER JOINTS

Because sleeve is always in perfect alignment when joint is made and because its design minimizes deformation of tubing, Hi-Duty Fittings assure stronger joints that remain leakproof even under severe service. Tests show Hi-Duty joints will stand over 5 times as much vibration as joints made with ordinary compression or flare fittings.

Average Time Required to Assemble Fittings

Type of Fitting	Average Time Each Joint	Joints per Hour
HI-DUTY	13.2 sec.	274
Regular Compression	20.8 sec.	173
Flare	45 sec.	80

See Your Industrial Supply House

THE IMPERIAL BRASS MANUFACTURING COMPANY

1204 W. Harrison St., Chicago 7, Ill.

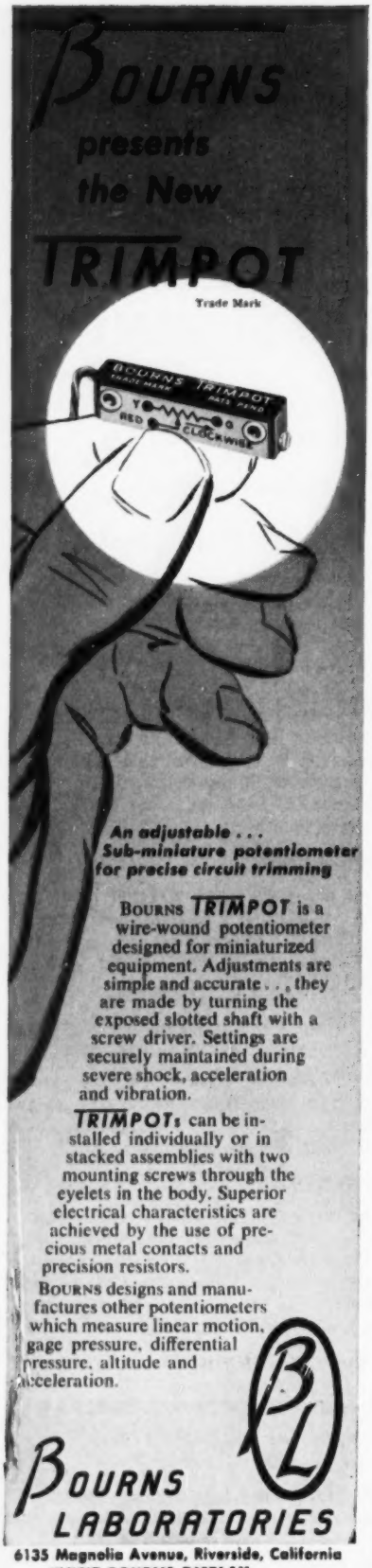
In Canada: 334 Lauder Ave., Toronto, Ontario

IMPERIAL

Pioneers in Tube Fittings and Tube Working Tools

See us at Booth 37-38, National Instrument Exhibit

For more information circle 59 on inquiry card.


BOURNS
presents
the New
TRIMPOT
Trade Mark
BOURNS TRIMPOT
RED
CLOCKWISE
An adjustable . . .
Sub-miniature potentiometer
for precise circuit trimming
BOURNS TRIMPOT is a wire-wound potentiometer designed for miniaturized equipment. Adjustments are simple and accurate . . . they are made by turning the exposed slotted shaft with a screw driver. Settings are securely maintained during severe shock, acceleration and vibration.
TRIMPOTs can be installed individually or in stacked assemblies with two mounting screws through the eyelets in the body. Superior electrical characteristics are achieved by the use of precious metal contacts and precision resistors.
BOURNS designs and manufactures other potentiometers which measure linear motion, gage pressure, differential pressure, altitude and acceleration.
BOURNS
LABORATORIES
6135 Magnolia Avenue, Riverside, California
"VISIT BOURNS DISPLAY—
Booth 283, I.S.A. Show."
For more information circle 60 on inquiry card.

NEW INSTRUMENTS

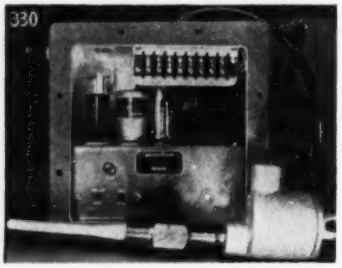
triggers one of two stages: (1) first stage usually sets off a local plant alarm so that plant personnel can investigate and take action before a serious hazard develops, (2) second stage operates at a predetermined higher smoke density, setting off a major alarm or extinguishing system, depending on type of equipment installed in system.—*Cardox Corp.*, 307 *S. Michigan Ave., Chicago* 1, *Ill.*

For more information circle 239 on inquiry card.

LEVEL

Liquid and Granular-material Level Detector

New "Electr-O-Probe" system detects level of granular materials and liquids under exceptionally severe conditions. Capacitance-type probe may

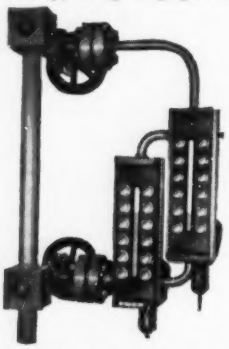


be used bare or with various insulating coatings for use with corrosive liquids or granular materials, can withstand temperatures from −65 F. to 1500 F. and pressures from 30 in. vacuum to 1000 psi. Indicating and amplifying unit is unaffected by temperatures from −40 F. to 200 F. and is encased in explosion-proof housing. —*Instruments, Inc.*, 122 *N. Madison, Tulsa, Okla.*

For more information circle 240 on inquiry card.

Separated-design Water Gage

New separated-design water gage assembly is said to assure greater dependability, longer gage life and

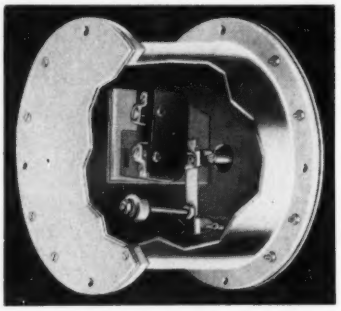


more accurate water level readings in high-pressure service. Gage glass inserts are of pressure-sealed "floating-assembly" type; gage valves are "Welbonds." Maker's "Type M" illuminators may be used on new separated-design gages.—*Yarnall-Waring Co., Chestnut Hill, Philadelphia* 18, *Pa.*

For more information circle 241 on inquiry card.

Bin-level Indicator

New lower-priced model of "Bantam Bin-Dicator" has over-all diameter of 5.75 in. and housing is so de-



signed that it may be mounted outside thin-walled bins, inside thick-walled or multiple-compartment bins, or suspended within bins.—*The Bin-Dicator Company*, 201-13946 *Kercheval, Detroit* 15, *Michigan.*

For more information circle 242 on inquiry card.

Liquid Level Controller

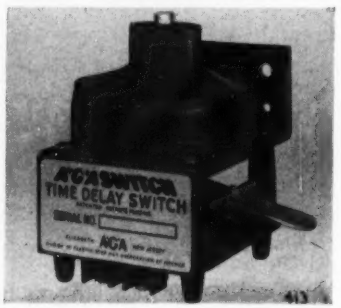
New floatless liquid level controller is of all-cold-cathode-tube design: no possibility of hot tube failure. Only contact with liquids (of both high and low electrical conductivity) is made by stainless steel rods: no moving parts inside tank; accuracy independent of pressure and temperature. Utilizing new "Haledy TT-1" triode, controller operates instantaneously, has unlimited life. Tube does not require filament or plate transformer or circuitry, uses no warm-up or standby current, has amplification factor of 2½ million.—*Haledy Electronics Co.*, 57 *William St., New York* 5, *N. Y.*

For more information circle 243 on inquiry card.

TIME and COUNT

Time Delay Switch

New "Agaswitch," for applications requiring a mechanically or manually initiated time delay, is operated by

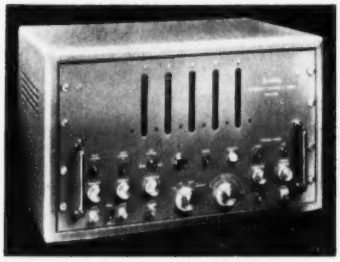


a lever rather than by solenoid action. Pressure against lever trips switch and a time delay period from 0.1 second to 5 minutes or more starts upon release of pressure on lever. Timing chamber is enclosed and dustproof, with air used for timing recirculated inside. Electrical rating for resistive loads is approx. 15 amp. at 115 v.ac. —*A'G'A' Div., Elastic Stop Nut Corporation of America, Elizabeth, N. J.*

For more information circle 244 on inquiry card.

Counter and Timer

New "Model 5500 Universal Counter and Timer" provides direct reading of elapsed time between any two



events, direct reading of number of events during a precise time interval, accurate means of measuring low frequencies, and straightforward electronic counting facility. Elapsed time range, 40 microseconds to 100,000 seconds; rates, 20 to 100,000 events per second. Direct presentation of results in either kilocycles or seconds with decimal point indication eliminates conversion.—*Berkeley Div., Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif.*

For more information circle **245** on inquiry card.

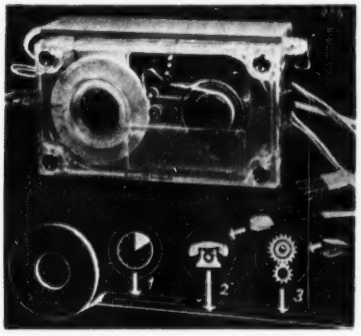
Tape-reel Time Markers

New time-indicating reel-marking stickers, for use during recording and playback of magnetic tape, are calibrated for use on standard 10.5-in. NARTB reels at 7.5 and 15-in tape speeds; are available only through maker's distributors: none available from factory.—*Ampex Electric Corp., Redwood City, Calif.*

For more information circle **246** on inquiry card.

Operation-time Recorder

New "Magazine Recorder" uses ¼-inch electrosensitive paper, has one stylus for time-marks (1) and



two others for operation records (2 & 3) from N-O or N-C switches on motor, machine, or other device under study.—*Alden Electronic and Impulse Recording Equipment Co., Westboro, Mass.*

For more information circle **247** on inquiry card.

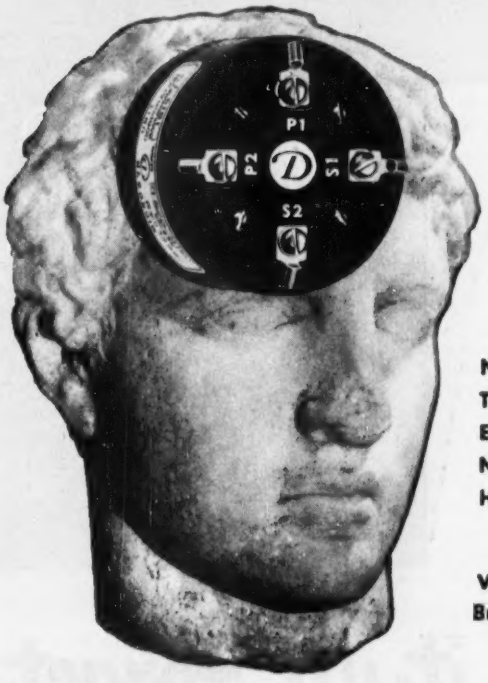
Degree Counter

New degree counter for navigating and directional instruments indicates in degrees, minutes, and tenths of minutes; fits into panel so that degrees are read in one opening and minutes and tenths in another opening approx. 1.5 in. to the right. Speed

A new tool for angular measurement

Doelcam

POSITION INDICATOR Microsyn



No electrical contacts
True linearity
Extreme resolution
No reaction torque
High sensitivity

Write for Bulletin M4

IN INDUSTRIAL AND MILITARY applications, this small electromechanical signal generator transforms angular displacement into an electrical signal. It provides a linear output and a resolution to less than 0.01°. Tested and perfected as a standard military component for use in gyro instruments and computers, the DOELCAM Microsyn Position Indicator is now finding wide application in the industrial fields of process control, data transmission, measurement of mechanical variables and analog computation.

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SOLDIERS FIELD ROAD, BOSTON 35, MASS.
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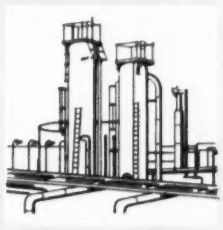
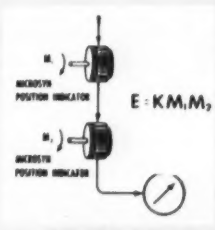
Data Transmission

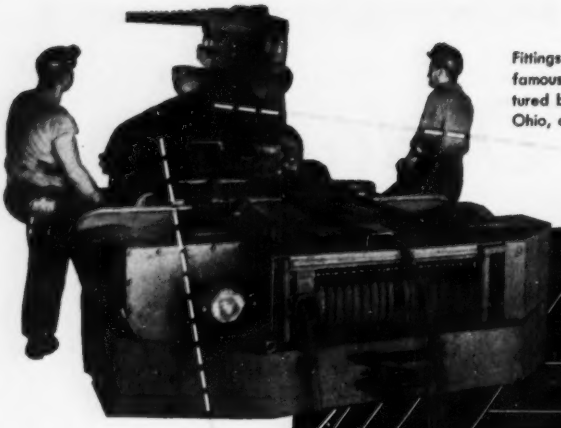


Process Control

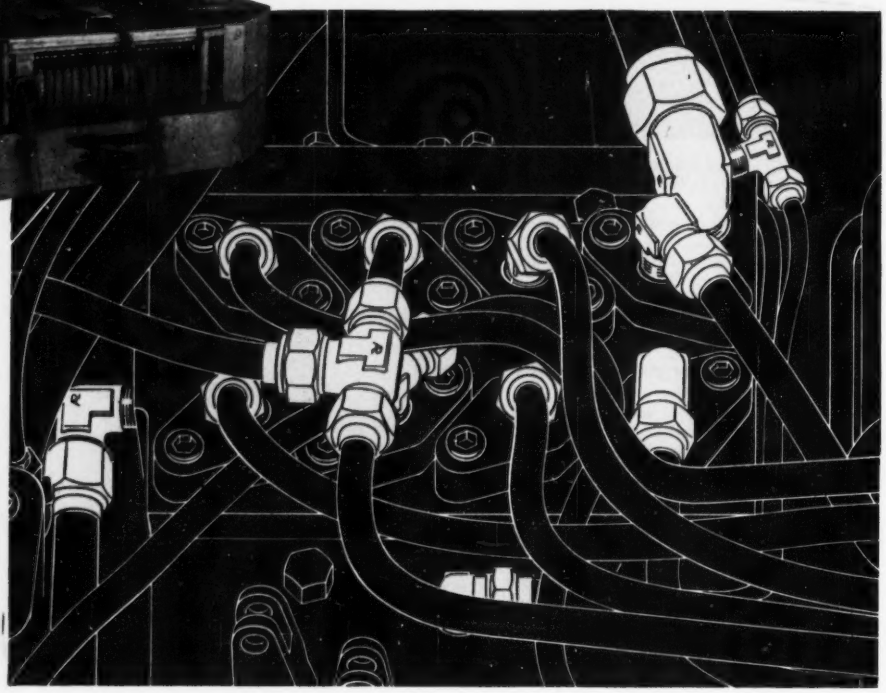


Computation

For more information circle **61** on inquiry card.



Fittings on the hydraulic system of the famous Universal Coal Cutter, manufactured by The Jeffrey Mfg. Co., Columbus, Ohio, are PARKER trouble-free Triple-lok.



on coal cutters

Tube it up...Forget it...WITH PARKER

TROUBLE-FREE TRIPLE-LOK FITTINGS

Few machines get rougher use than coal cutters in coal mines. Subjected to severe vibration, caused by the action of the cutting head, and operating under the most adverse conditions, all parts must be ruggedly built, including the hydraulic system.

You'll find Parker Triple-lok Fittings on coal cutters and many other machines used in rough, rugged service because they are leakproof under the severest conditions of vibration, elevated temperatures, high pressures and repeated assembly. Parker Fittings meet the specifications of the A.S.M.E. Code for Pressure Piping, as well as J.I.C. and S.A.E. standards.

So *tube it up* and *forget it* . . . with Parker Triple-lok Fittings. Ask your Parker Distributor for Tube Fitting Catalog 4300, or write The PARKER Appliance Company, 17325 Euclid Avenue, Cleveland 12, Ohio.

This does it

Triple-lok . . . 3-piece flare fitting famous for its sleeve . . . the easiest way to install tubing systems. Made in brass, steel, stainless steel, aluminum alloy.

Precision Mark of

Leakproof Tube Fittings

Parker

TUBE FITTINGS • VALVES • O-RINGS

Plants in Cleveland • Los Angeles • Eaton, Ohio • Berea, Ky.

For more information circle 62 on inquiry card.

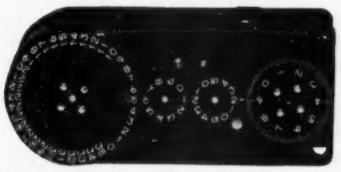
Parker

INDUSTRIAL TUBE FITTING
STOCKS CARRIED BY

AKRON 9, O.—B. W. Rogers Co., 850 So. High St.
ARDMORE, Pa.—Louis H. Hein Co., 15 West Lancaster Ave.
BALTIMORE 13, Md.—Carey Machinery & Supply Co. 3501 Brehms Lane
BALTIMORE 5, Md.—Whitehead Metal Products Co. 4300 E. Monument St.
BEAUMONT, Tex.—Standard Brass & Mfg. Co., 705 Milam St.
BOSTON 15, Mass.—A. E. Borden Co., 176 Brookline Ave.
BRYSON CITY, N. C.—Wallace Co. of Carolina, P.O. Box 572
BUFFALO 7, N. Y.—Whitehead Metal Products Co. 2128 Elmwood Ave.
CAMBRIDGE 39, Mass.—Whitehead Metal Products Co. 281 Albany St.
CEDAR RAPIDS, Ia.—Globe Machinery & Supply Co. 309 8th Ave., S. E.
CHICAGO 14, Ill.—Wallace Tube Co., 1300 Diversey Pkwy.
CINCINNATI 29, O.—Williams & Co., 3231 Fredonia Ave.
CLEVELAND 14, O.—W. M. Pattison Supply Co. 777 Rockwell Ave.
CLEVELAND 15, O.—B. W. Rogers Co., 1900 Euclid Ave.
CLEVELAND 14, O.—Williams & Co., 3700 Perkins Ave.
COLUMBUS 8, O.—Williams & Co., 851 Williams Ave.
DALLAS 9, Tex.—Metal Goods Corp., 6211 Cedar Springs Rd.
DAVENPORT, Ia.—Globe Machinery & Supply Co. 410 East Second St.
DAYTON 10, O.—J. N. Fauver Co., 1534 Keystone Ave.
DENVER 2, Colo.—Metal Goods Corp., 2425 Walnut St.
DES MOINES 6, Ia.—Globe Machinery & Supply Co. East First & Court Ave.
DETROIT 1, Mich.—J. N. Fauver Co., 49 West Hancock St.
HARRISON, N. J.—Whitehead Metal Products Co. 1000 South Fourth Ave.
HOUSTON 3, Tex.—Metal Goods Corp., 711 Milby St.
HOUSTON 1, Tex.—Standard Brass & Mfg. Co. 2018 Franklin St.
INDIANAPOLIS 27, Ind.—Korhumel Steel & Aluminum Co. 3562 Shelby St.
JACKSONVILLE, Fla.—Florida Metals Inc. 2937 Strickland St.
KANSAS CITY 16, Mo.—Metal Goods Corp., 1300 Burlington Ave., North Kansas City
KNOXVILLE 5, Tenn.—Leinart Engineering Co. 412 E. 5th Ave.
LOS ANGELES 4, Cal.—Haskel Engineering & Supply Co. 721 W. Broadway, Glendale
LOS ANGELES 12, Cal.—Metropolitan Supply Co. 353 East 2nd St.
MEMPHIS, Tenn.—J. E. Dilworth Co., 730 South Third St.
MILWAUKEE 3, Wis.—Morman Belting & Supply Co. 522 W. State St.
MILWAUKEE 4, Wis.—Wallace Cos. of Wisconsin 838 So. 6th St.
MINNEAPOLIS 15, Minn.—Vincent Brass & Copper Co. 124 Twelfth Ave., So.
NEW ORLEANS 12, La.—Metal Goods Corp., 432 Julia St.
NEWPORT NEWS, Va.—Noland Co., 27th St. & Virginia Ave.
NEW YORK 12, N. Y.—Nielson Hydraulic Equipment, Inc. 298 Lafayette St.
NEW YORK 14, N. Y.—Whitehead Metal Products Co. 303 West 10th St.
PHILADELPHIA 40, Pa.—Whitehead Metal Products Co. 1955 Hunting Park Ave.
PITTSBURGH 33, Pa.—Williams & Co., 901 Pennsylvania Ave.
PORTLAND 10, Ore.—Hydraulic Power Equipment Co. 2316 N. W. Savier St.
ROANOKE 10, Va.—Noland Company, 11 Salem Ave.
ROCKFORD, Ill.—Rockford Tool & Transmission Co. 802 Broadway
SALT LAKE City 4, Utah—Pace-Turpin & Company 726 South Third, West
SAN FRANCISCO 3, Cal.—General Machinery & Sup. Co. 1346 Folsom St.
SEATTLE 9, Wash.—Palmer Supply Co., 222 Westlake, N.
SHREVEPORT, La.—Standard Brass & Mfg. Co. 1557 Texas Ave.
ST. LOUIS 15, Mo.—Metal Goods Corp., 5239 Brown Ave.
SYRACUSE 4, N. Y.—Whitehead Metal Products Co. 207 W. Taylor St.
TOLEDO 2, O.—Williams & Co., 650 E. Woodruff Ave.
TULSA, Okla.—Ardun Supply Co., 317 S. Detroit
TULSA 3, Okla.—Metal Goods Corp., 302 North Boston
CANADA—Railway & Power Engineering Corp. Ltd.
EXPORT—Mercator Corp., 438 Walnut St., Reading, Pa.

For more information circle 62 on inquiry card.

NEW INSTRUMENTS



capability is 2200 rpm. on first dial; torque is 0.4 in.-oz. at 300 rpm. A Nylon transfer pinion minimizes noise and friction.—*Durant Mfg. Co.*, 1981 *N. Buffum St., Milwaukee* 1, *Wis.*

For more information circle 2.8 on inquiry card.

COMPUTING

Hand Calculator

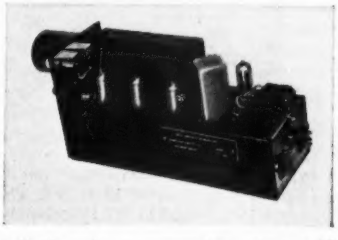
New "Model II" calculator handles problems of 11 x 8 x 15 digits; this increased capacity over "Model I"

having been achieved with little sacrifice in weight and portability: it fits easily in hand and weighs 12 oz. —*Curta Calculator Co.*, 3851 *W. Madison St., Chicago* 24, *Ill.*

For more information circle 249 on inquiry card.

Computer Memory Package

New "Model 3C1-384" memory unit, comprising a solid acoustic delay line and associated circuitry ready for in-

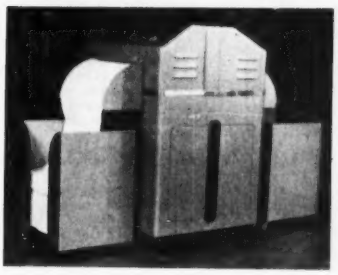


stallation in a computer, stores 384 bits at a pulse repetition rate of 1 Mc. A self-contained heating element and thermostat stabilize quartz line. All germanium diodes are grouped in a single plug-in sub-unit. Reshaped output signal level is 15 volts into a 100-ohm impedance load. Carrier frequency is 20 Mc.—*Computer Control Co.*, 106 *Concord Ave., Belmont* 78, *Mass.*

For more information circle 250 on inquiry card.

Printer for Computer or Magnetic Tape

New "High Speed Printer" is capable of producing "hard copy" from output of an electronic computer or



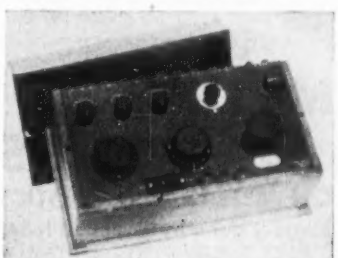
magnetic tape; is adaptable to data handling, inventory control, or production of subscriber labels; prints up to 108,000 characters per minute; uses pre-punched flat-folded forms; will print on a four-part form. Format control devices are available to utilize the printer to print into a pre-printed form. "Model 134" (illustrated) is a drum type printer, 120 columns in width; columns spaced 6.4 per inch along printed line; 55 characters around perimeter of drum for printing in each column. Printers are available in a range of sizes, character spacings, and character complements. Printing rates of 1800 lines per minute can be obtained where only digital information is to be processed. —*Shepard Laboratories*, 480 *Morris Ave., Summit, N. J.*

For more information circle 251 on inquiry card.

FOR THE LABORATORY

Laboratory Potentiometer

New "E-3040-AW Laboratory Standard Potentiometer" has been completely redesigned. All switch con-



tacts and slide-wire scale are beneath panel, free from dust. Scale is read through window. Ranges: 0 to 1.811 volts, 181.1 mv. and 18.11 mv. Additional binding posts for use in checking laboratory type wattmeters, and for operating from 3- or 6-volt source. —*Gray Instrument Co.*, 64 *W. Johnson St., Philadelphia* 44, *Pa.*

For more information circle 252 on inquiry card.

Bacteria Filters

New "Schott-Jena Fritted Glass Filters" of porosity 5, produced from Schott G-20 glass, highly resistant to water and acids, are available in three groups with nominal max. pore sizes of 3 to 1.7 microns, 1.7 to 1 micron,

GRIP ON

TO YOUR SMALL PARTS HANDLING PROBLEM . . .

with the NEW *AUTOMATIC* PICK-UP TWEEZER

A practical, versatile, ALL STAINLESS STEEL instrument designed to make the handling of small objects an easier, less time consuming operation.

Indispensable for picking-up, positioning or holding hot, sterile, highly polished, or oddly shaped objects and for getting into hard to reach spaces.

Pressing the plunger causes 3 Strong, Hooked, Spring Steel Fingers to extend from the tip and flare out.

Releasing the plunger causes them to withdraw. Any object within their grasp is then firmly held WITHOUT CONTINUED FINGER PRESSURE.

Send for your Tweezers of a thousand uses today, and see how and where this practical versatile tool can aid you:

- In manufacturing
- Laboratory situations
- Component assembly
- Precision work
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FULLY GUARANTEED
PRICE $2.25

WIN SALES COMPANY
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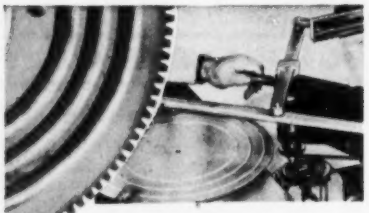
FOREST HILLS, N. Y.

For more information circle **63** on inquiry card.



PANTOGRAPHIC

MILLING OF SPIRALS

ON METALS AND PLASTICS

Rapidly done by unskilled labor

with **NEW HERMES**

Engravograph

Write for Literature
Catalog H37 Bench Type Model (weight 200 lbs.)
Portable Model IM also available

Production: 6" brass spiral with ¼" x ¼" groove cut from 3 times larger template. Time: 12 units per hour.

NEW HERMES, INC. 13-19 University Place, N.Y. 3
Representatives in all principal cities.
Canada—359 St. James St., Montreal

For more information circle **64** on inquiry card.

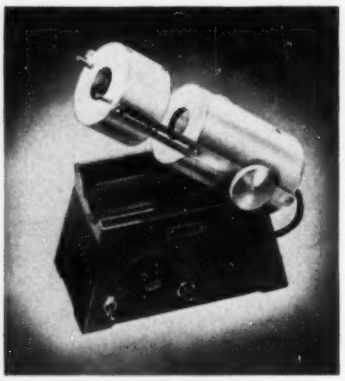
NEW INSTRUMENTS

and under 1 micron. Filter disks are individually tested by a new method assuring uniform pore measurements and a test certificate is furnished with each filter.—*Fish-Schurman Corp., 70 Portman Road, New Rochelle, N. Y.*

For more information circle **253** on inquiry card.

Sublimation Apparatus

New unit for identification and purification of materials by sublimation at temperatures from room to 300 C.,



comprises an electrically-heated cylindrical block furnace mounted in line on a common frame with a water-cooled condenser. Two types of sublimation tube, for semi-micro and micro samples respectively, are offered.—*E. H. Sargent & Co., 4647 Foster Avenue, Chicago 30, Ill.*

For more information circle **254** on inquiry card.

Laboratory Oven

New model of "Thermo-Wall Oven" features "Hazard-safe Radiant Wall Heating," hydraulic thermostat with

"walking" contact points, temperature range from room to 260 C. Two sizes available, with working chambers 13 x 13 x 13 in. and 18 x 20 x 17.5 in. —*Labline, Inc., 217 N. Desplaines St., Chicago 6, Ill.*

For more information circle **255** on inquiry card.

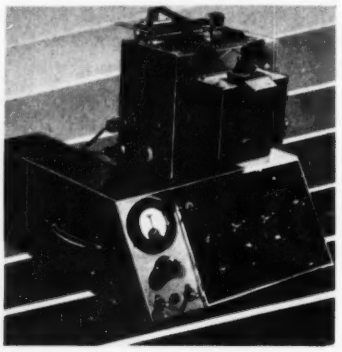
Mortar and Pestle

New mortar-&-pestle set, made of tool steel, is designed for use in both conventional manual method and automatically with maker's mortar grinder.—*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.*

For more information circle **256** on inquiry card.

Colorimeter

New model of "Color and Color Difference Meter" incorporates an electronic galvanometer, gives numerical

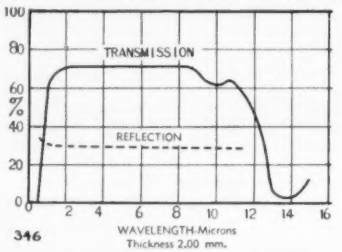


results using National Bureau of Standards units, permits discovery and quantitative measurement of almost-invisible effects of aging or treatment, can be operated by average production or laboratory technician. —*Gardner Laboratory, Inc., 4723 Elm St., Bethesda 14, Md.*

For more information circle **257** on inquiry card.

Infrared-transmitting Glass

New "Servofrax" (arsenic trisulfide glass) is said to be superior in physical, chemical and optical properties to other substances available for



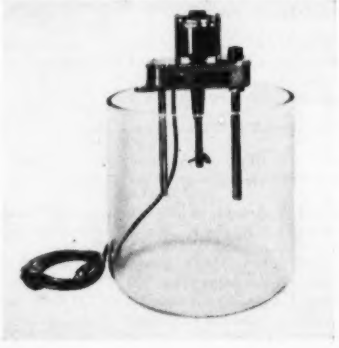
346

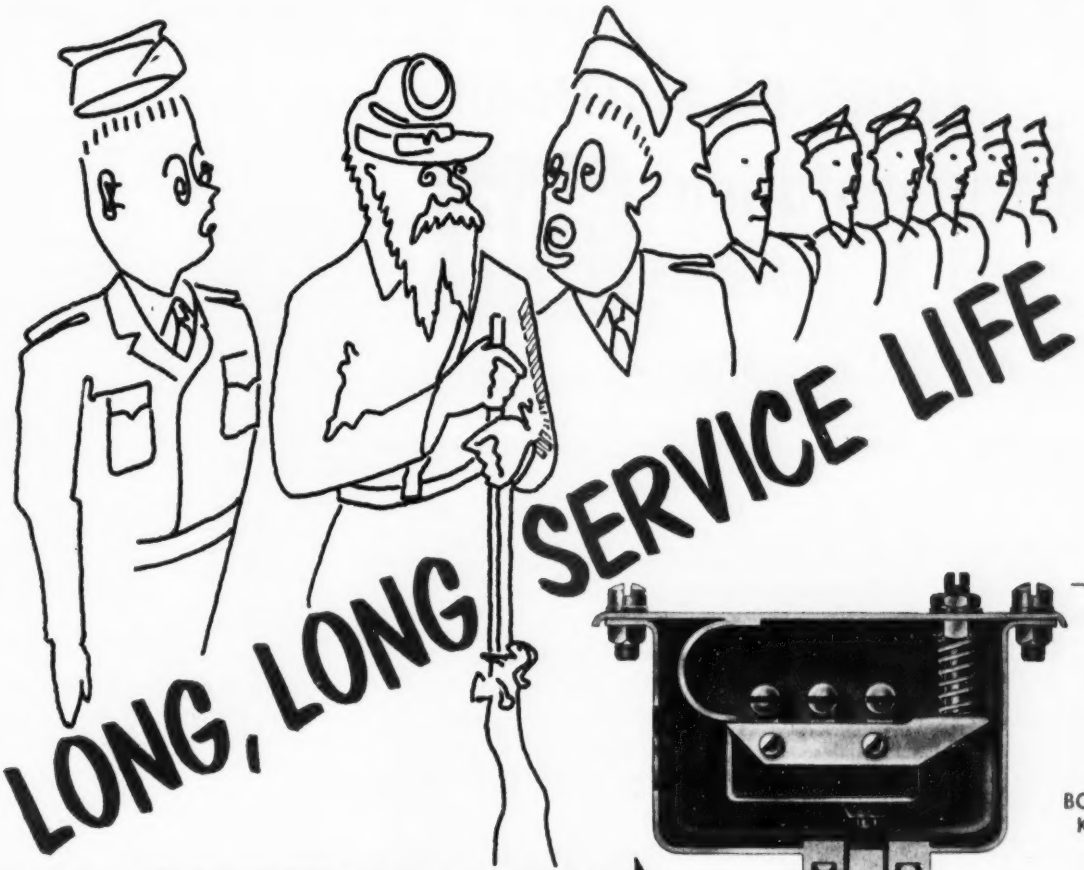
infrared systems where ordinary glass will not pass longer wavelengths. It is available in flat windows, lenses, optical corrector plates and raw glass form. Most chemicals, gases, water, etc. have no adverse effect on it.—*Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y.*

For more information circle **258** on inquiry card.

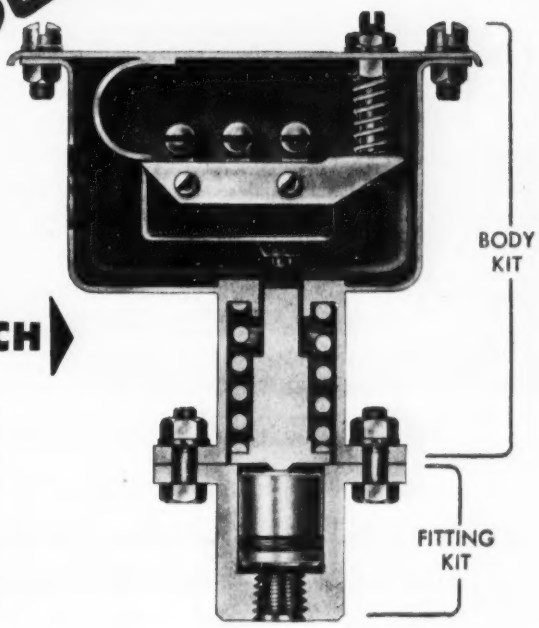
Constant-temperature Bath

New "S-84870" water bath establishes a constant-temperature reservoir for laboratory work. Circulating





MODEL 9612 PRESSURE SWITCH



Belongs where millions of cycles are expected, on production equipment, where service troubles are taboo. The original equipment manufacturer can design this component into his product and profit by these additional advantages: Extreme flexibility—the same body kit converts to an infinite number of service conditions by simply changing fitting kits—(see table); High proof pressure even at low settings—protection against surge damage; No unwanted actuation from vibration or harmless line surges; Switch may be mounted in any position—no levelling or balancing required; Mounting bracket adjustable up and down and 360° around the neck of the switch; Tamperproof external setting of adjustable range; All this and more at a lower price than inferior switches due to production savings without sacrifice of quality, a quality standard that has long maintained a high rating for Barksdale and Meletron pressure switches and valves. You are dealing with a national organization, represented in every major industrial trading area by competent field engineers.

Write for bulletin 9612 and the chart on "How to select the correct model Barksdale-Meletron Pressure Actuated Switch for your Application."

PROOF PRESSURE	ADJUSTABLE RANGE	HYD. OIL SERVICE	WATER, AIR, GAS SERVICE
3000 P.S.I.	15 - 200 P.S.I.	-0-H FITTING KIT	-0-WA FITTING KIT
3000 P.S.I.	35 - 400 P.S.I.	-1-H FITTING KIT	-1-WA FITTING KIT
7000 P.S.I.	125 - 1500 P.S.I.	-2-H FITTING KIT	-2-WA FITTING KIT
7000 P.S.I.	250 - 3000 P.S.I.	-3-H FITTING KIT	-3-WA FITTING KIT

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For more information circle 65 on inquiry card.

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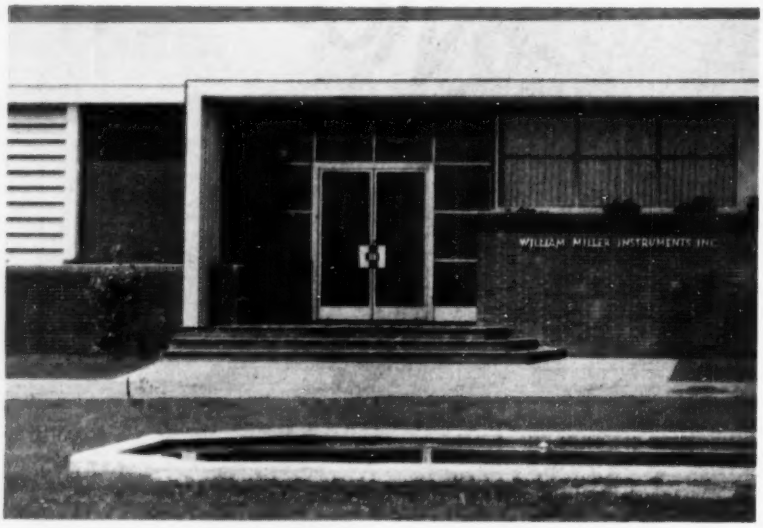

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For more information circle 66 on inquiry card.

NEW INSTRUMENTS

and heat control systems are enclosed in a metal housing supported on rim of a 12x12-in. Pyrex brand glass reservoir. Settings from room temperature 60 C.—*E. H. Sargent & Co.*, 4647 *W. Foster Ave., Chicago* 30, *Ill.*

For more information circle 259 on inquiry card.

Automatic Pipette

New "Volupettor" is a new type of automatic pipette and reservoir assembly for reagent stock and working solutions: a complete dispensing unit for exact duplicate volumes. It is available in two sizes: 2 ml. and 5 ml., graduated in 0.1 ml.—*Standard Scientific Supply Corp.*, 34 *W.* 4*th St., New York* 12, *N. Y.*

For more information circle 260 on inquiry card.

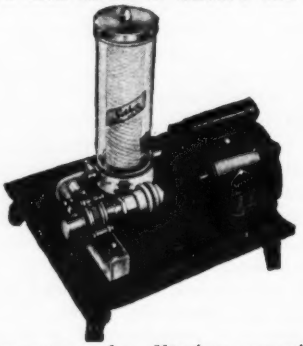
Diesel Lube-oil Tester

New "Rotrode" direct-sparking equipment, with already-installed spectrographic instrumentation, eliminates time-consuming and costly ashing technique; makes routine analysis of Diesel lube oils practical, fast and comparatively low in cost.—*Applied Research Laboratories*, 3717 *Park Place, Glendale* 8, *Calif.*

For more information circle 261 on inquiry card.

Self-priming Filter Pumps

New "Model LSIN-5" (50 gal./hr.) and "Model LSIN-10" (100 gal./hr.) have been added to maker's line of



filter pumps for filtering corrosive solutions from pH 0 to pH 14, removing particles down to one micron. —*Sethco Mfg. Co.*, 70-78 *Willoughby St., Brooklyn* 1, *N. Y.*

For more information circle 262 on inquiry card.

Buechner-type Funnels

New "Schott-Jena Slit-Sieve" Funnels, of Buechner Type with fused-in glass disk having narrow elongated slit holes, are characterized by high thermal durability and extreme resistance to acids and alkalies. Any possible residue within funnel can easily be seen. Glass disks produced by

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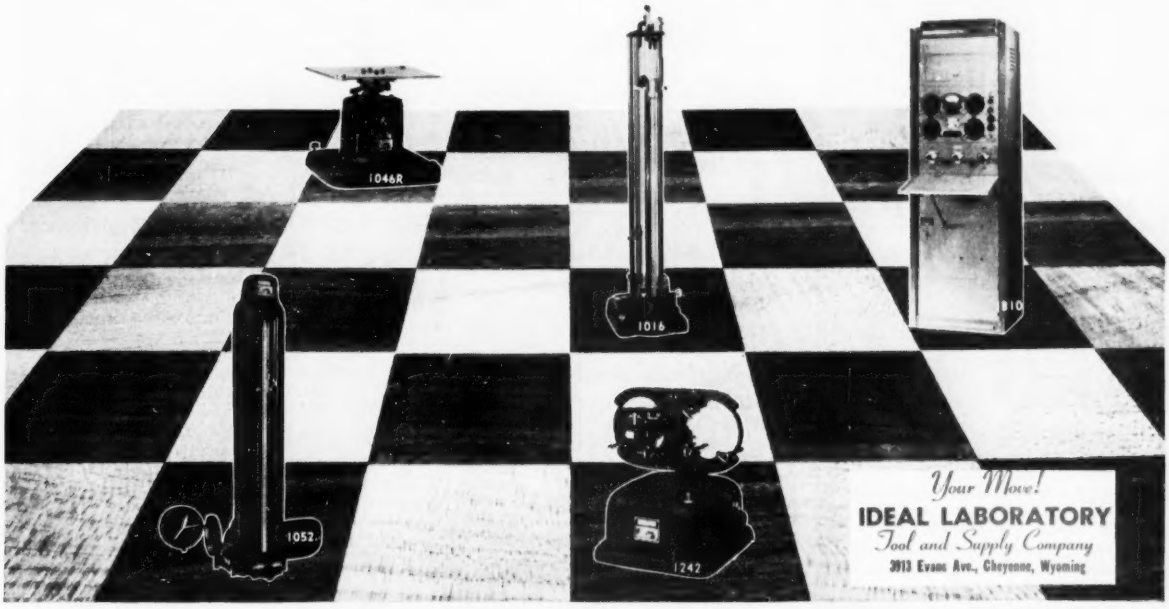


Model 1052 Automatic Indicating Barometer

Model 1046R Testing Table for All Gyro Aircraft Instruments

Model 1016 Barometer for Altimeter Calibrating

Model 1242 4-Speed Turn and Bank Tester

Model 1810 Tachometer Test Stand

For more information circle 67 on inquiry card.

"slit-sieve" method have holes uniformly placed throughout perfectly plane surface, permit quick filtration, prevent tearing filter paper.—*Fish-Schurman Corp., 70 Portman Road, New Rochelle, N. Y.*

For more information circle 263 on inquiry card.

Plastic Funnels

New sizes of funnels have been added to polyethylene laboratory items: funnels are now available in ¾, 4, 6, and 7¼-in. sizes.—*Bel-Arts Products, 2209 Central Ave., Union City, N. J.*

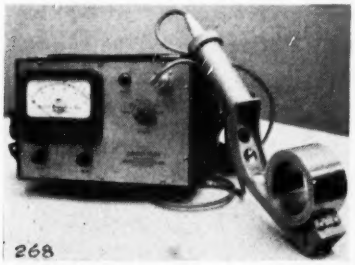
For more information circle 264 on inquiry card.

INSPECTION

Gamma-radiation-type Thickness Gage

New "Penetron Junior" utilizes gamma radiation to measure wall thickness of piping non-destructively, from one side only, without shut-down. Two sizes of tangential heads are available for pipes up to: (1) 8.5 in. OD; (2) 12.75 in. OD. Radiation source is shielded for personnel protection. Two instruments are available: (1) battery-operated; (2) for 115 v.ac. Accuracy, 3 percent of wall thickness.—*United Engineers, Inc., 820 E. Sixth St., Tulsa, Okla.*

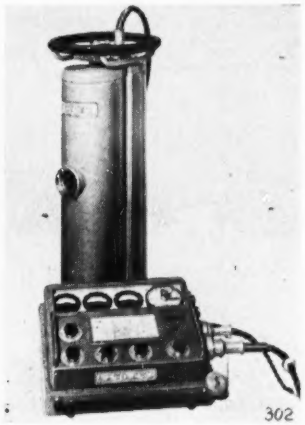
For more information circle 265 on inquiry card.



Industrial X-ray Unit

New "Andrex" 250-kvp industrial x-ray unit weighs less than 350 lbs., fits into trunk compartment of a late model automobile; requires little or no servicing; will penetrate 4 in. of steel. Focal spot is 4 mm, and at a focus-film distance of 24 in. a 17-in. film is covered. New unit is the only one made which is able to operate on 110 v.ac. (besides 220 and 440, 50 or 60 cps.).—*Holger Andreasen, Inc., 703 Market St., San Francisco, Calif.*

For more information circle 266 on inquiry card.



Industrial X-ray Unit

New "Norelco MG 160" transportable industrial X-ray unit fits into automobile trunk, is designed specifically for rapid inspection of welds, pipe lines, power plant, ship and aircraft equipment.—*X-ray Dep't, Non-Destructive Testing Div., North American Philips Co., Inc., 750 S. Fulton Ave., Mount Vernon, N. Y.*

For more information circle 267 on inquiry card.

Fluorescent Hand Lamps

New "Lite Mite" fluorescent portable inspection units, with or without magnification, offer intense, glare-

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For more information circle 69 on inquiry card.

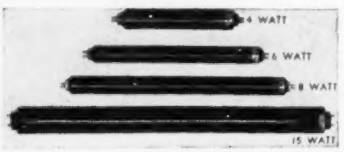
NEW INSTRUMENTS

free white light without heat. Four power lens is straddled by twin fluorescent lamps. Units can be equipped instantly for ultraviolet radiation.—*Stocker & Yale, Inc., Marblehead, Mass.*

For more information circle 268 on inquiry card.

Near-ultraviolet Lamps

New "Raymaster Blacklight Lamps" are, essentially, low-pressure mercury arc sources of long-wave ultraviolet ("blacklight") filtered to



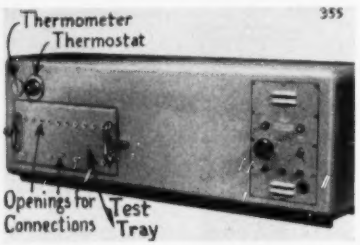
remove most of visible light. Principal application: to excite fluorescent pigments and materials for comparisons, determinations, and detections. Energy peak is close to 3600 A-u.; practically no radiation shorter than 3000 A.u.; no effect on eyes or skin. Required auxiliaries such as ballast, lamp starter and holders, etc., are standard and readily obtainable, or can be furnished by manufacturer.—*George W. Gates & Co., Inc., Franklin Square, L. I., N. Y.*

For more information circle 269 on inquiry card.

TESTING

Temperature Test Chamber

New "Model TC-1 Temperature Test Chamber," for temperatures between −65 F. and 275 F., has forced circulation to prevent any significant

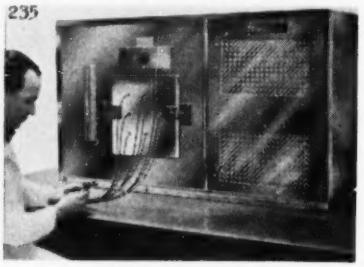


temperature variations between thermometer and object on test tray. Cooling is by "dry ice;" heating by a high-capacity strip heater. Chamber is portable and self-contained, designed for tests on basic instruments, sub-assemblies, etc.—*Statham Development Corp.*, 12411 *W. Olympic Blvd., Los Angeles* 64, *Calif.*

For more information circle 270 on inquiry card.

Temperature Test Chamber

New "High-Low Temperature Bench-Type Test Chamber" features rapid pull-down of temperature: to

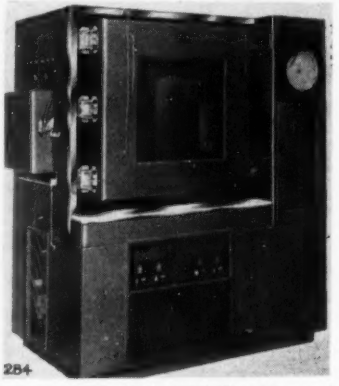


minus 80 F. in 30 minutes or less. High temperature (to 185 F.) is attained through use of reverse-cycle refrigeration, eliminating open-heating-element hazards. Removable door illustrated has mounting board affixed to its back, on which devices may be mounted for testing.—*Dep't 229, Webber Mfg. Co.*, 2740 *Madison Ave., Indianapolis* 3, *Indiana.*

For more information circle 271 on inquiry card.

Temperature and Humidity Test Chambers

New multi-range test chambers produce low temperatures to −130 F., high temperatures to 200 F. and a standard humidity cycle of 20 to 95

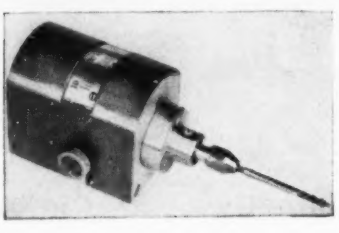


percent from 35 to 185 F.; are made in five sizes with test space capacity from 4 to 36 cu. ft. Among features: high-capacity low-velocity forced-air circulation system with motor mounted outside cold test space; electric defrost system.—*Murphy & Miller, Inc.*, 1326 *South Michigan Avenue, Chicago, Ill.*

For more information circle 272 on inquiry card.

Torsion Tester

New "Model N.935" torsion tester is built around a calibrated "Iso Elastic" spiral spring mounted on a shaft



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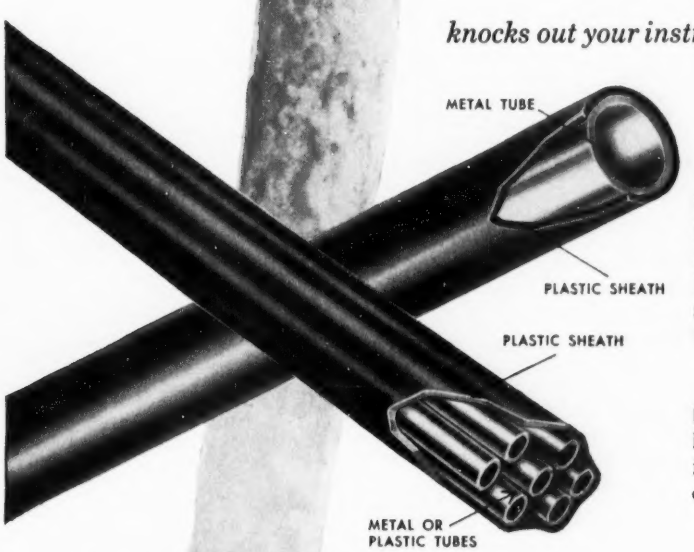

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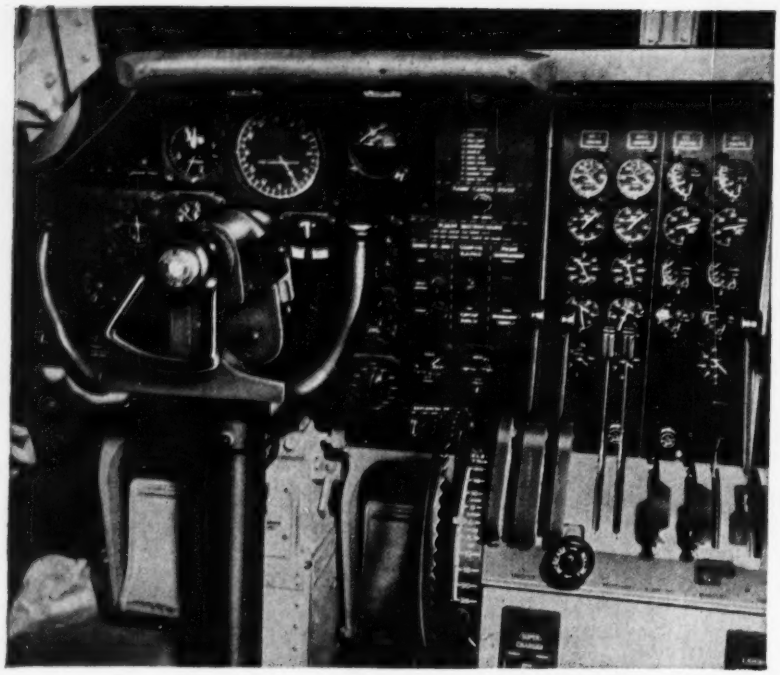
For more information circle **70** on inquiry card.



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DIALS — NAMEPLATES — EDGE-LIGHTED PANELS

For more information circle 71 on inquiry card.

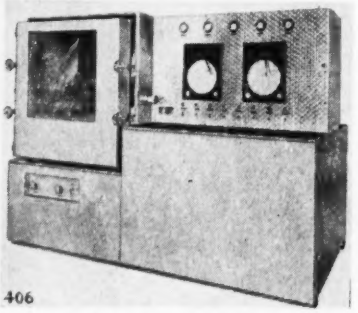
NEW INSTRUMENTS

seated in two low-torque bearings. Capacity of model illustrated, 40 g.-cm.; dial scale divisions, 2 g.-cm.; inherent bearing-friction error, 0.25 g.-cm. Tester can be made in almost any capacity, clockwise or counterclockwise or both.—*John Chatillon & Sons, 85 Cliff St., New York 38, N. Y.*

For more information circle 273 on inquiry card.

Altitude Test Chamber

New "Strato-Chamber," redesigned to incorporate advanced heat-transfer and control methods, is available in 5- to 48-cu. ft. sizes, for operation



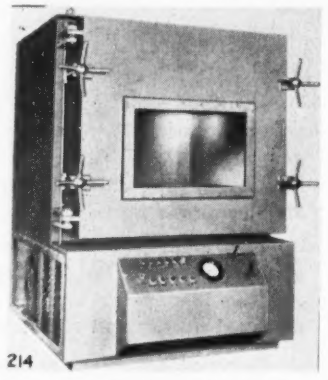
406

between 200 F and either −70 F., −85 F., or −100 F., at which point each standard model is capable of carrying a 200-watt "live" load. Also humidity control between 20 and 95 percent, and pressure control from atmospheric to equivalent of 100,000 ft.—*Hudson Bay Div., Refrigeration Systems, Inc., 646 W. Washington Blvd., Chicago 6, Ill.*

For more information circle 274 on inquiry card.

Altitude Test Chamber

New "Altitude Simulation Chamber," multi-purpose environmental test unit, provides wide range of tem-



214

perature, vacuum and humidity conditions. Available with optional equipment, such as program heating, cooling and humidity cycles, and instruments for controlling and integrating temperature, humidity and altitude.—*Murphy & Miller, Inc., 1322 South Michigan Avenue, Chicago, Ill.*

For more information circle 275 on inquiry card.

Gyro Test Set

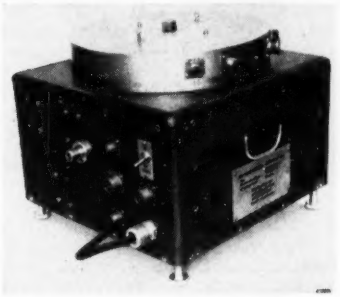
New "Model TAV Gyro Test Set," when employed with gyro testing fixtures, reduces time required to adjust

gyro rotor bearings lubricated by oil; is said to reveal certain faults of gyro rotor assembly components which cannot be detected by other means. Its functions are (1) to measure gyro rotor speeds; (2) to measure gyro rotor deceleration directly in coast time from 8 to 16 minutes; (3) to give audible and visual indications at different speeds. Unit weighs 62 lbs. exclusive of constant-voltage transformer and connecting cables furnished as standard equipment.—*TLG Electric Corp.*, 31 *W. 27th St., New York* 1, *N. Y.*

For more information circle **276** on inquiry card.

Gyro Test Turntable

New "Model A Gyro Test Turntable" has 12-in. turntable, provides five speeds of 36, 90, 180, 360, and

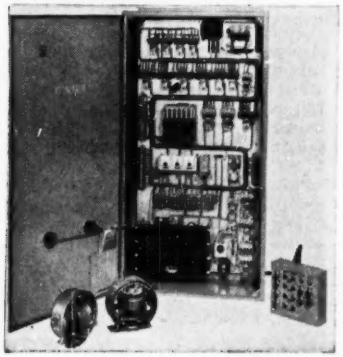


1080 degrees per minute. Fourteen coin-silver slip rings with carbon brushes provide arrangements for power input and test outputs. Pneumatic connections are made through one pressure or vacuum line feed.—*Mechanical Div., General Mills, Inc.*, 2003 *E. Hennepin, Minneapolis* 13, *Minn.*

For more information circle **277** on inquiry card.

Electric Motor Tester

New "Automatic Testing Panel" tests all types of single-phase electric motors at rate of 1800 per day



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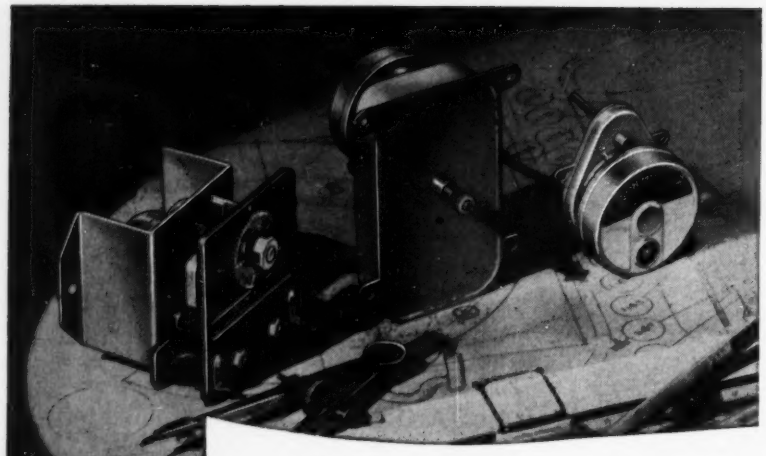
For more information circle **72** on inquiry card.



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HEADQUARTERS FOR
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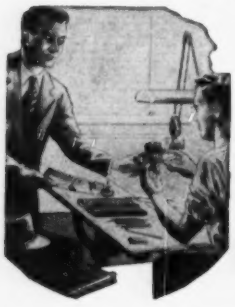
TIME DELAY RELAYS • SPECIAL TIMING DEVICES
TIMING ENGINEERING SERVICES

HAYDON* specializes in a varied line of standard timing components and custom engineered devices for volume application.

Our research and engineering staffs are constantly seeking to develop new and better ways to harness time for industrial, commercial and military applications.

In the field, HAYDON maintains a staff of engineers whose training, backed up by years of experience, enables them to help manufacturers insure, insofar as timing components can, the satisfactory performance of their products. The entire staff and rapidly expanding plant facilities of HAYDON are devoted solely to the production of timing motors, timing devices and clock movements.



AT YOUR SERVICE

The knowledge and skill of our field engineers and our research and engineering facilities are available to help you solve timing problems. Write us in detail or ask that we send a field engineer to talk things over.

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HAYDON Mfg. Co., Inc.
Subsidiary of GENERAL TIME CORP.
2032 ELM STREET
TORRINGTON, CONNECTICUT

For more information circle 73 on inquiry card.

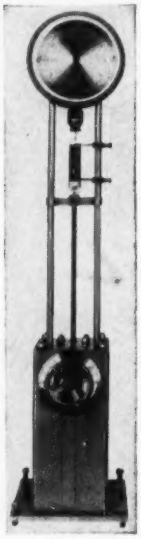
NEW INSTRUMENTS

for continuity of windings, correct terminal connections, hi-potential, ground and run tests. An audible alarm and a red light indicate specific fault.—*Gemco Electric Co., 25685 W. 8-Mile Rd., Detroit, Mich.*

For more information circle 278 on inquiry card.

Tensile Tester

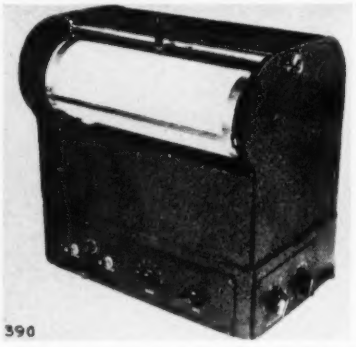
New Small Capacity Tensile Tester, for fibre, cloth, cord, rubber, etc., is operated by means of a handwheel graduated to read extension to 0.001 in. Worm gear holds tension at any given point. Load pointer remains at maximum load until reset to zero. Standard capacities from 1 to 100 lbs. Dial diameters from 7.75 in. for smaller capacities to 10 in. for larger. (Metric graduations also available.) Tester is approx. 36 in. high; maximum extension distance 15 in. Easily-adjusted tolerance pointers are held to dial arm by permanent magnets. —*John Chatillon & Sons, 85 Cliff St., New York 38, N. Y.*



For more information circle 279 on inquiry card.

Stress-strain Recorder

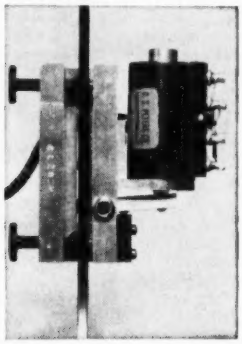
New stress-strain recorder records load by movement of stylus parallel to drum axis; stylus driven by mechanical connection to load-indicating element of testing machine. Two ranges: one providing full recorder scale for 50 percent and the other for 100 percent of each indicator range. Strain is recorded by rotation of motor-driven drum; circuits similar to those used in maker's round-chart strain recorders. Adapters also permit recording output of "SR-4" strain gages attached directly on surface of test specimens, so that full-scale ten-inch record of strains ranging from 800 to 80,000 microinches can be obtained.—*Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.*



For more information circle 280 on inquiry card.

Extensometer

New "Model P-101 M" extensometer for measuring and recording elastic deformation in tensile test specimens

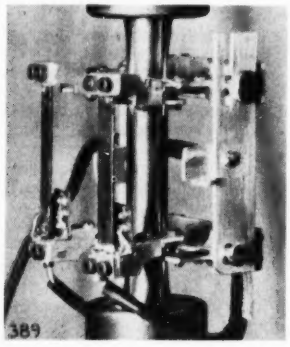


of sheet metal, can be used on 0.5-in. wide specimens 0.005 to 0.25 in. thick. Gage length is 2 in. Magnifications of 250, 500 and 1000 are obtainable over a measuring range of 0.04 in. with suitable recording equipment. Electrically, new unit is of "Microformer" type. Mechanically, it consists of a pair of Dural channel sections, each supporting one of the two clamping contact points at ends of gage length. Their relative movement changes position of "Microformer" core.—*Baldwin-Lima-Hamilton Corp., Philadelphia* 42, *Pa.*

For more information circle **281** on inquiry card.

Extensometer

New "SR-4 Extensometer" transmits electrical signal proportional to elongation, has "SR-4" strain gages



bonded to two vertical spring strips (left) which push points on ends of their arms into conical depressions in knife-edge plates on gripping head. Strains are thus sensed on opposite sides of specimen (Wheatstone-bridge arms).—*Baldwin-Lima-Hamilton Corp., Philadelphia* 42, *Pa.*

For more information circle **282** on inquiry card.

Bonded-wire Strain Gage

New "Type AB-32" of "SR-4" bonded resistance wire strain gage is smallest yet developed. It has a gage length of 1/32 inch (half that of former smallest gage); is a Bakelite-base gage of wrap-around type with cupro-nickel wire; is applied by phenol-resin cement. Nominal resistance, 120 ohms; average gage factor, 1.4.—*Baldwin-Lima-Hamilton Corporation, Philadelphia* 42, *Pa.*

For more information circle **283** on inquiry card.

Tension-test Signalling and Control Instrument

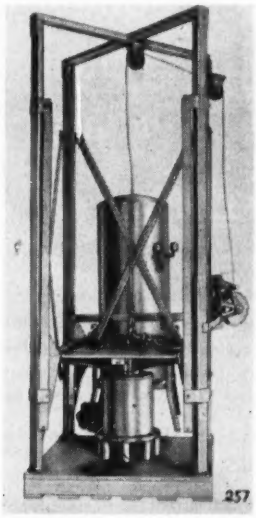
New "Extension Indicator" for measuring extension under load in tension test specimens, and automat-

ically controlling auxiliary devices, is applicable to any type of testing machine in conjunction with any standard high-magnification "Microformer" type extensometer of any gage length. —*Baldwin-Lima-Hamilton Corp., Philadelphia* 42, *Pa.*

For more information circle **284** on inquiry card.

Shock Test Machine

New "Shock Test Simulator," said to be the first apparatus which will simulate accurately true shock con-



ditions encountered in the field, drops equipment to be tested through a measured free fall, submits it to a predetermined deceleration for a sufficiently long time to reproduce actual shock conditions, and automatically repeats cycle in the manner of a bouncing ball. Records can be obtained as proof for filing. Standard models up to 30 *G* with controlled duration of deceleration; special models up to 100 *G* or greater.—*American Research Corp.*, 11 *Brook St., Bristol, Conn.*

For more information circle **285** on inquiry card.

Iridium-192 Sources

New iridium radiography sources, for non-destructive testing of steel from 0.25 in. to 1 in. with 2 percent definition, will also give excellent results on aluminum and magnesium. Average gamma energy of Ir-192 is about 450 kev. Source (2mm. x 2mm.)

"We've found that 'soaping' Swagelok Tube Fittings is just a waste of time . . ."

The power plant pictured above is equipped with Swagelok Tube Fittings installed by Midwest Piping & Supply Company, Inc.

Midwest Superintendent Moran says, "We always 'soap' each joint after original installation. Testing Swagelok Fittings revealed no leaks whatever. We've found that 'soaping' Swagelok Tube Fittings is just a waste of time . . ."

Here's further impressive proof that Swagelok Fittings are leakproof . . . on Ultra-High Vacuum applications, Swagelok Fittings commonly are used in the range of 10^{-7} millimeters of mercury.

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CRAWFORD FITTING CO.

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For more information circle **74** on inquiry card.

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YOU CAN READ THE ANSWER DIRECTLY ACCURATELY AND EASILY

without computation or interpolation on this Potter Megacycle Frequency-Time Counter. For maximum versatility, complete reliability, and proved performance, this unique instrument is outstanding. One compact unit provides the means for these basic tests.

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The Only Universal

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PERIOD for one or ten cycles of the unknown.

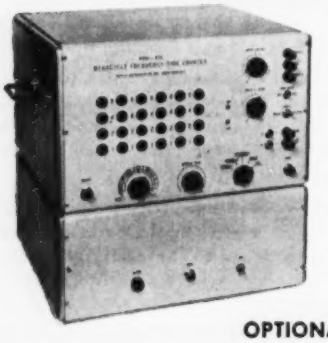
TIME INTERVAL from 30 microseconds to 1,000,000 seconds.

FREQUENCY RATIO for two unknown frequencies.

TOTAL COUNT from 1 to 10^6.

RPM with an accuracy of $\pm$ 1 rpm at any speed.

TIMING in increments of 10 or 100 usec; 1, 10, or 100 millisecs; or 1 sec.



Use it, too, as an accurate secondary frequency standard with outputs of 100, 10 and 1 kc; 100, 10, 1 and .1 cps.

OPTIONAL FEATURES

such as additional decades, mechanical registers, preamplifiers, and 1 mc crystal for interval resolutions to one usec, further increase the utility of the Model 850.

Only Potter Instruments offer a choice of the famous Potter 1-2-4-8 four lamp readout for maximum reliability and readability or the 0-9 ten lamp readout for direct digital indication. Adjustable display time for either indication provides automatic or manual reset after the reading period.

As accessory equipment the Potter Instrument Company can also supply high speed printers and digital magnetic tape handlers for recording the digital information.

If you are now using awkward, time-consuming methods of measurement, you can save time and money by putting this universal measuring instrument into your program now. Like every Potter product, the Model 850 is the industry standard, and is always specified wherever results are important. For complete information and our recommendations on your specific laboratory or production problem, write to Department 8-I, the Potter Instrument Co., Inc., Great Neck, New York.

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115 CUTTER MILL ROAD **GREAT NECK, N. Y.**

113

For more information circle 75 on inquiry card.

NEW INSTRUMENTS

is sealed in an aluminum capsule attached to a steel head for handling with a remote magnetic handler. Standard source strength 1.25 curies; others on special order. Regular irradiations are scheduled every two months.—*Tracerlab Inc.*, 130 *High St.*, *Boston* 10, *Mass.*

For more information circle 285 on inquiry card.

Transistor Analyzer

New "Model TA-1 Transistor Analyzer," said to be the first commercial transistor current gain meter and curve tracer, measures emitter-to-collector current gain (commonly called alpha) of both *n*-type and *p*-type point contact transistors, and base-to-collector current gain (commonly called beta) of *p-n-p* and *n-p-n* type transistors, directly on a panel indicator. When used with an oscilloscope, it produces curves of alpha against emitter current and beta against base current. Constant collector voltage is obtained from a regulated power supply whose output is available for external use.—*Polyphase Instrument Co.*, 705 *Haverford Road*, *Bryn Mawr, Pa.*

For more information circle 287 on inquiry card.

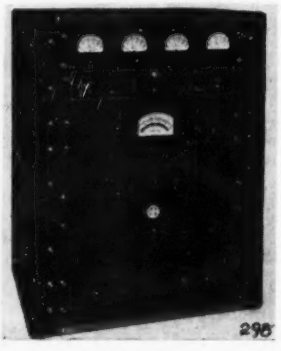
Transistor Analyzer

New "Model 2 Transistor Characteristic Plotter" automatically displays, on an auxiliary 'scope, any one of four families of static characteristic curves: transfer characteristic (V_{IN} vs. I_C) and collector characteristic (V_C vs. I_C) for both grounded-emitter and grounded-base connections. It accommodates *n-p-n* and *p-n-p* junction transistors as well as point-contact transistors. Input-current step increments are adjustable from 5 to 1000 ma.; collector voltage is adjustable up to 50 volts peak-to-peak. Curves permit grading transistors and determining all small-signal transistor parameters including alpha. Display axes are calibrated by internal calibration signals.—*Dunn Engineering Associates*, 11 *Windsor St.*, *Cambridge*, *Mass.*

For more information circle 288 on inquiry card.

Transistor Analyzer

New "Model T-61 Transistor Test Set" tests small-signal behavior of all point contact and junction transistors; measures four independent parameters of four-terminal equivalent circuit of transistor over complete operating range, thus yielding the quan-

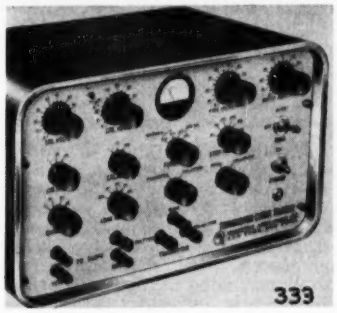


titative data needed for circuit design. Flexibility assures continued usefulness with future types. Overall accuracy is 2 percent. Unit contains all requisite measuring instruments; is powered by 8 separate regulated power supplies for operation without adjustment despite line voltage variations.—*Transistor Products, Inc., Snow and Union Sts., Boston, Mass.*

For more information circle 239 on inquiry card.

Transistor Analyzer

New "Automatic Transistor Curve Tracer," for designing transistor circuits, comparing, matching and se-

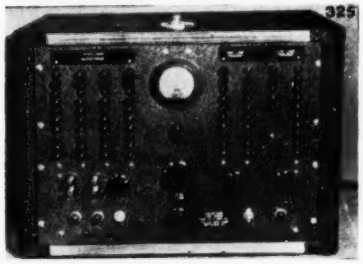


lecting, studying effects of temperatures, age, etc., features flexibility of design to accommodate future types. It dynamically plots entire family of curves simultaneously on standard laboratory d-c. oscilloscopes. Calibrating axes generated internally as part of 'scope display are always in proper quadrant.—*Magnetic Amplifiers Inc., 632 Tinton Ave., New York 55, N. Y.*

For more information circle 290 on inquiry card.

Capacitor Tester

New "Model OS-2 Precision Capacitance Limit Bridge" was designed specifically for testing capacitors

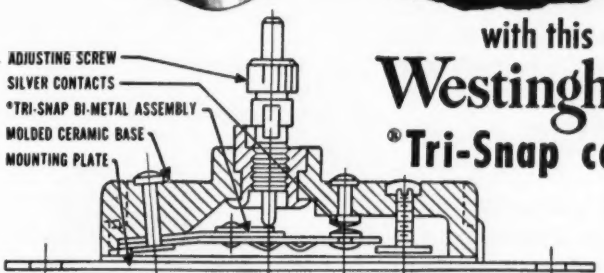


under JAN, RMA and RTMA procedures. Among claimed features: excellent stability, positive "go, no-go" indication, adjustable tolerance ranges, provision for remote measurement, adaptable to automatic operation. New bridge performs high-speed checking of capacitors between 0.0001 mfd and 1 mfd. Primary component is a Schering bridge, basic accuracy of which is 0.3 percent for all ranges.—*Gulton Mfg. Co., Metuchen, N. J.*

For more information circle 291 on inquiry card.

Vibration-test Controller

New "Servo" system automatically controls displacement or acceleration level of shaker tables used in product



with this
Westinghouse
®Tri-Snap control

Product of Westinghouse Electric Corporation, Meadville, Pennsylvania

Westinghouse Tri-Snap® thermostats in butter warmer compartments of household refrigerators permit storing butter at a temperature higher than that of the food storage compartment. Thus a housewife can select a butter temperature that assures her the spreading consistency she desires. The snap action, quick make-quick break, is largely dependent upon precise Chace Thermostatic Bimetal.

The butter compartment is warmed by a molded wire resistor under the box. The crimping of the outer edges of the slotted bimetal element shortens the over-all length, placing the center section under compression. As the bimetal deflects due to the rise and fall of ambient temperature, the "oil-can" effect of the distorted center causes a sharp make-and-break contact with the resistor. Opening the gap between contacts lengthens the "off" period, hence the spreading consistency may be controlled to the queen's taste.

Chace engineers, recognized authorities on temperature responsive devices invite you to consult with them before designing your new temperature actuated control. Our 29 types of thermostatic bimetal are available in strips, coils, random long lengths and welded or brazed sub-assemblies. Write for our 32-page booklet "Successful Applications of Chace Thermostatic Bimetal."

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Thermostatic Bimetal
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For more information circle 76 on inquiry card.

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Project Group Leader and others with experience applicable to pneumatic controls for pneumatic power turbines and aircraft refrigeration systems

An immediate requirement exists for a qualified Project Engineer to head a Controls Group, and for several Controls Engineers for one of the leading manufacturers of aircraft accessories, specializing in pneumatic power turbines and refrigeration equipment for military and commercial aircraft.

A knowledge of pneumatic controls and background in hydraulic and electrical controls is desirable.

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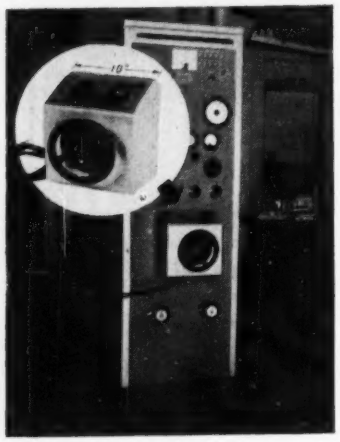
For more information circle **77** on inquiry card.

NEW INSTRUMENTS

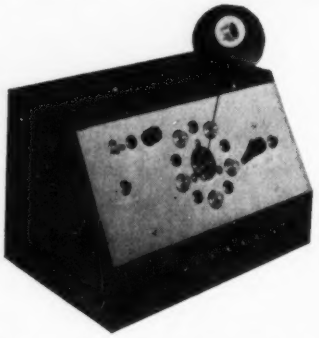


vibration analysis; is for use with maker's signal monitor and frequency cycler. Manual override and limit relays insure an ample safety factor. Manual operation is possible without disengaging or detaching "Servo."—*Calidyne Co., 751 Main St., Winchester, Mass.*

For more information circle **292** on inquiry card.

Commutator Tester

New self-contained commutator tester increases speed and efficiency of testing sub-miniature and fractional-hp. motor commutators. Two tests (high-rate precision test for shorts, and dielectric test of barrier materials) are made at rate of 90 to 200 per hour without removing or repositioning part under test. After tests, commutator is automatically ejected. Units can be provided to test commutators from 0.125 in. to 6 in. For commutators larger than 6 in., console type with holding fixture. Tester can be made automatic by using a sequence timer actuated by insertion of part.—*ConRay Corp., 1225-27 Ray St., Dayton, Ohio.*



For more information circle **293** on inquiry card.

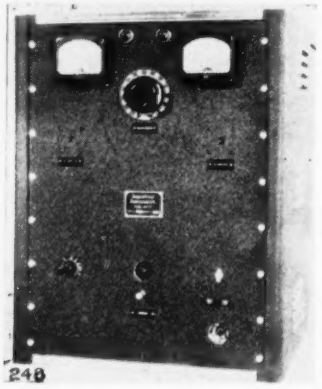
Auto Vibrator Tester

New "12VT1D" vibrator tester, for auto radio servicemen, will test directly, without adapters, either 6- or 12-volt vibrators of most popular types, and all auto radio vibrators used since 1940.—*P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind.*

For more information circle **294** on inquiry card.

H-v. Breakdown Tester

New "Model P-7-20" high-voltage-breakdown tester supplies a.c. or d.c. continuously variable between 0 and 20,000 volts at maximum currents of approx. 15 ma. d.c. or 20 ma. a.c. Short circuit current is limited by internal resistance of test set: no damage if maintained. Cut-off control provided so that power is turned off when load current exceeds any preset value from 5 to 20 ma. Load current, a.c. or d.c., read directly on milliammeter; d-c. voltage and peak a.c. voltage read directly on voltmeter.—*Industrial Instrumets, Inc., 89 Commerce Road, Cedar Grove, N. J.*

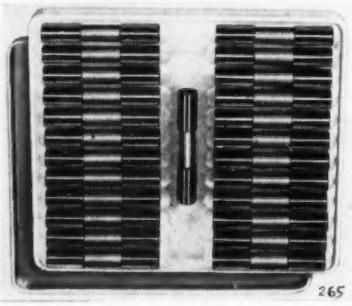


For more information circle **295** on inquiry card.

FOR INSTRUMENT SHOP

Plug Gage Set

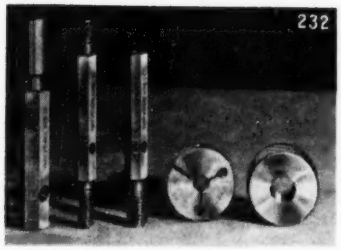
New set of 25 plug gages, said to represent a new system of precision gaging, consists of one gage of nominal size, 12 gages, increasingly larger in 0.0001-in. increments, and 12 gages increasingly smaller in 0.0001-in. decrements. Cost of set is said to approximate that of one go-and-no-go gage. Available at present time in any nominal size from 1/8 in. to 1 in. in increments of 1/64's.—*Deltronic Corp., 9010 Bellanca Ave., Los Angeles 45, Calif.*



For more information circle **296** on inquiry card.

Hard-surfaced Gages

New "Electrolized Gages" are said to "last many times longer than ordinary hardened steel gages," by reason of an even 25-microinch film of hard, non-magnetic alloy applied to all gaging surfaces during electrolizing process, which imparts a tough surface much harder than tool steel. Surface

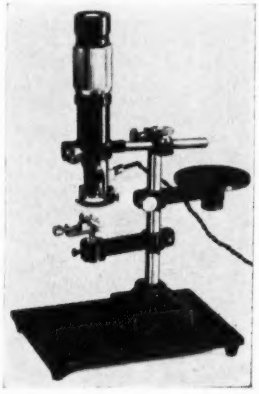


smoothness minimizes friction. Electrolizing process can be applied to maker's standard or special gages, and to "CompAIRator" air gage members.—*The Taft-Pierce Mfg. Co., Woonsocket, R. I.*

For more information circle **297** on inquiry card.

Measuring Microscope

New "Optometer Model GR," newest in maker's line of measuring microscopes, is available in two magnifi-

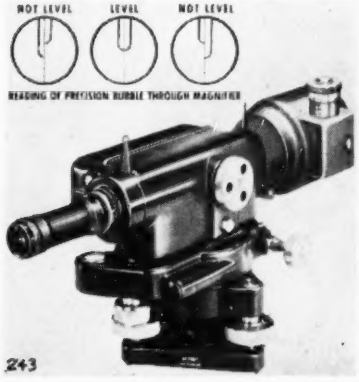


cations: 20-power with a field of view of 0.580 in. and a measuring scale that reads directly to 0.002 in.; 40-power with 0.290-in. field and 0.001-in. readings. Additional features include a swivel-mounted work-holding vise, rotating table, built-in illuminator and detachable base plate.—*National Instrument Co., 5005 Queensbury Ave., Baltimore 15, Md.*

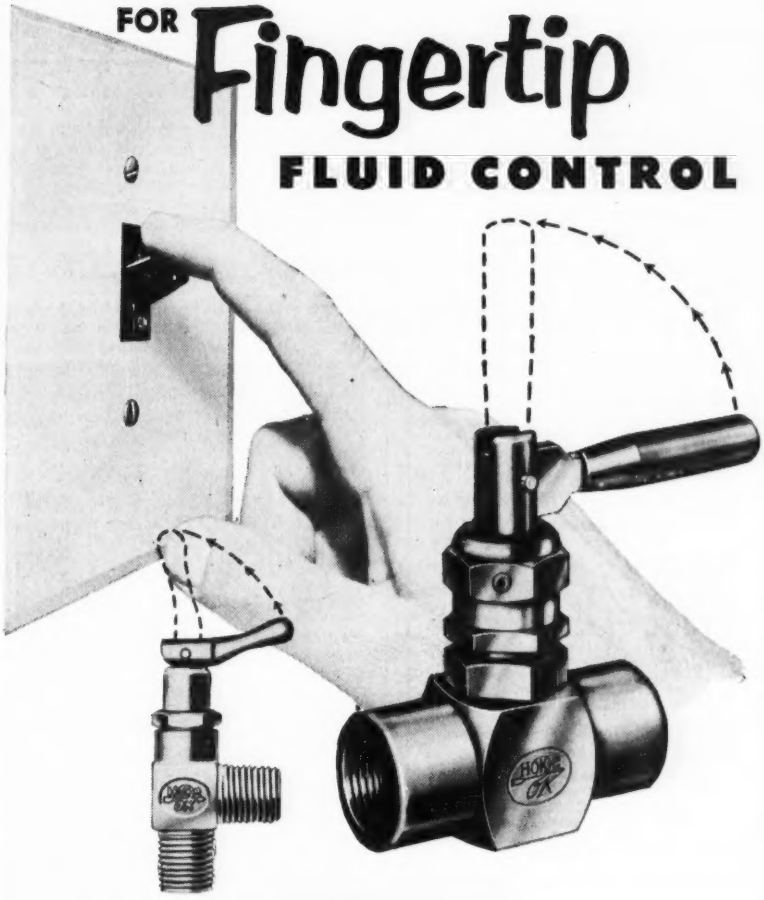
For more information circle **298** on inquiry card.

Precision Level

New "Microptic Level B131A" is a surveyor's precision level modified for shop, etc. Features: built-in precision level of split-bubble type; telescope with erecting eye-piece; graticule for



FOR Fingertip FLUID CONTROL



HOKE TOGGLE VALVES

Opened or closed with a single, positive motion—like a light switch—these HOKE toggle valves will improve the design of your instrument panel or test stand. Use them to control gas or liquid, at pressures up to 1000 psi or in high vacuum, with no leakage through stem or seat. They are available in ⅛", ¼", ⅜" and ½" sizes, in brass or stainless steel. The seat material, normally synthetic rubber, may be altered to meet specific conditions. Both straight line and angle type are ideal for instrument panel installation and can be mounted easily and securely with a lock nut. Several types are available with plastic knobs of various colors, for quick identification of fluids. For fingertip fluid control—for time-saving, dependable, efficient performance—specify HOKE Toggle Valves. Write Hoke Inc., 231 S. Dean St., Englewood, N.J., for Catalog & Data Sheets.

HOKE

HOKE INCORPORATED
Fluid Control Specialists
ENGLEWOOD, NEW JERSEY

For more information circle **78** on inquiry card.

ALFAX UNIVERSAL RECORDING PAPER

For the first time there is available an indelible recording paper — ALFAX — that is NOT subject to humidity, temperature or capillary action problems usually associated with pen and ink or papers marked by arcing or heat.

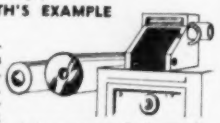
ELECTRICITY IS THE INK THAT MARKS ALFAX

Alfax paper can be marked by current as low as one volt and is instantaneous, permanent and stable. Highly sensitive Alfax is capable of fourteen steps by simply varying the current through the paper.

Alfax is the only paper that is capable of high speed recording, stable before or after recording, is non-transferable, has low current consumption at high speeds, can record at high humidity, over all temperature ranges, is smudge proof and non-toxic, widths from ¼" to 72".

Alfax opens a whole new field of monitoring and recording of phenomena which never before have been done easily and cheaply.

THIS MONTH'S EXAMPLE



To find material defects in gun barrels a Govt. arsenal applied a helix recorder with Alfax paper that graphically recorded the inside of the barrel, instantly showing the exact information needed. No other recording medium was suited to this job.

Request Booklet—Describe your problem

Alfax Paper & Engineering Co.

Alden Research Center, Westboro, Mass.

ENGINEERING SERVICE TO RECORDER MANUFACTURERS

For more information circle 79 on inquiry card.

HARDNESS TESTING...

done WITH NO MENTAL HAZARDS. The SCLEROSCOPE has done it for the past 47 years.

In general use for specification purposes. Simple, sturdy Comparatively inexpensive.

Illustrated bulletins free

The Shore Instrument & Mfg. Co., Inc.

90-35 Van Wyck Expressway Jamaica 35, N. Y.

For more information circle 80 on inquiry card.

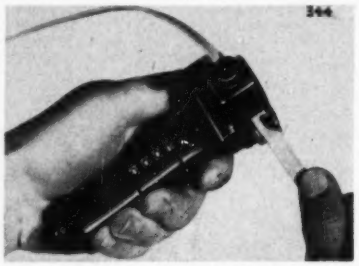
NEW INSTRUMENTS

both a scale and target reading. Optical micrometer reads directly to 0.001 in. over a range of 0.25 in. Leveling rods of 3 ft. and 6 ft. lengths as well as special scales are available as accessories.—*Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill.*

For more information circle 299 on inquiry card.

Wire-length Gage

New "Tel-Ryte" is a hand-held wire measuring unit that can also measure fabric, sheet metal, glass, etc. in any



length from 1 in. to 1,000 ft. and in sizes up to ⅜ in. It will either add or subtract and has a zero-reset knob. —*Rytel Electronics Mfg. Co., 9820 Irwin Ave., Inglewood, Calif.*

For more information circle 300 on inquiry card.

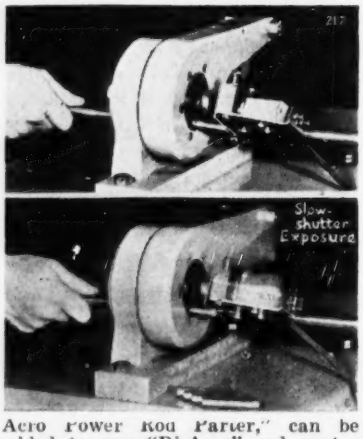
Internal Groove Gage

New "P-11" portable groove gage checks diameter and roundness of internal grooves; covers a range of groove diameters up to 5 in. and will check grooves located to a depth up to 1 in. or 2 in. from a face, depending on diameter of groove. A precision dial indicator shows variation from basic size; an indication of roundness of groove is obtained if work-part (or gage) is rotated.—*Bryant Chucking Grinder Co., Springfield, Vermont.*

For more information circle 301 on inquiry card.

Automatic Gage for Rod Cut-off Length

New "Micro-matic Gauge" makes it possible to maintain in excess of 9,000 cuts per hour in bar stock with "Di-

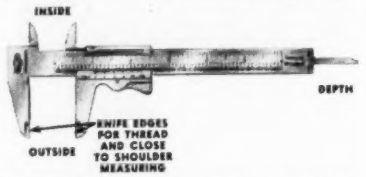


Acro Power Rod Parter," can be added to any "Di-Acro" rod parter in use.—*O'Neil-Irwin Mfg. Co., 644 Eighth Avenue, Lake City, Minn.*

For more information circle 302 on inquiry card.

Vernier Caliper

New "Model 101 Universal Mauser Vernier Caliper" for inside, outside and depth measurements, supersedes

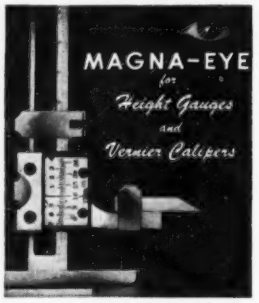


"Model 64." Material is now entirely stainless steel. New vernier with 25 lines covering 49 graduations of scale is more than twice as long as former type.—*George Scherr Co., Inc., 200-R Lafayette St., New York 12, N. Y.*

For more information circle 303 on inquiry card.

Vernier Magnifier

New "Magna-Eye" permits user to read vernier scales without eyestrain; magnifies four times; has a focus



limit stop to meet individual vision requirements. Made in three sizes, to fit standard American makes of gages and calipers.—*Stebar Co., 711 W. Lake St., Minneapolis 8, Minn.*

For more information circle 304 on inquiry card.

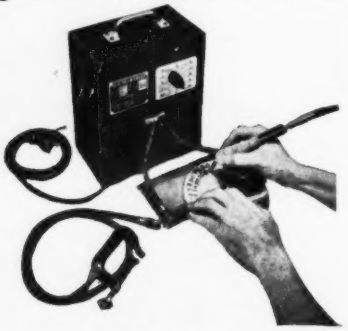
Drafting Templates

New drafting-room templates, for transferring repeated elements for drafting which remain constant from job to job, are furnished by undersigned company from drawings or sketches submitted by user.—*New Hermes Engraving Machine Corp., 13-19 University Place, New York 3, N. Y.*

For more information circle 305 on inquiry card.

Electric Markers

New "Electro-Marker Model EM-60" (500-watt standard model) and "EM-120" (1000-watt heavy-duty



Circle 81 on inquiry card. →

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COMPACT, PORTABLE
BENCH-TYPE TESTING UNIT FOR RAPID HIGH and LOW TEMPERATURES

Primarily developed for a branch of the armed forces, this high and low temperature testing unit has a temperature range from -80° F. to +185° F. Rapid temperature pull-down to -80° F. requires 30 minutes or less. Heat application is accomplished through reverse cycle refrigeration. Hazards of open heating elements are eliminated. Test chamber dimensions are 12"x12"x12" and the overall dimensions are 50" long, 26" high and 20" deep. Approximate weight is 450 pounds. The unit is compact and is entirely self contained. Controls are simplified and easy to operate. Equipped with air-cooled compressors, the unit is quiet in operation. Cabinet is of stainless steel with all controls visible. A blower is provided for even distribution of temperatures and greater testing accuracy. The door illustrated is a latch type door providing for complete removal from the cabinet. Holes may be drilled for electrical contacts.

This is one of the many examples of WEBBER engineering skill and another of the many firsts built by WEBBER in the low temperature field.

Write for more complete information:

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WEBBER MANUFACTURING COMPANY, INC., 2748 MADISON AVENUE, INDIANAPOLIS 3, INDIANA
(Formerly Webber Appliance Co., Inc.)

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TESTING UNITS

LOW-TEMPERATURE
INDUSTRIAL FREEZERS

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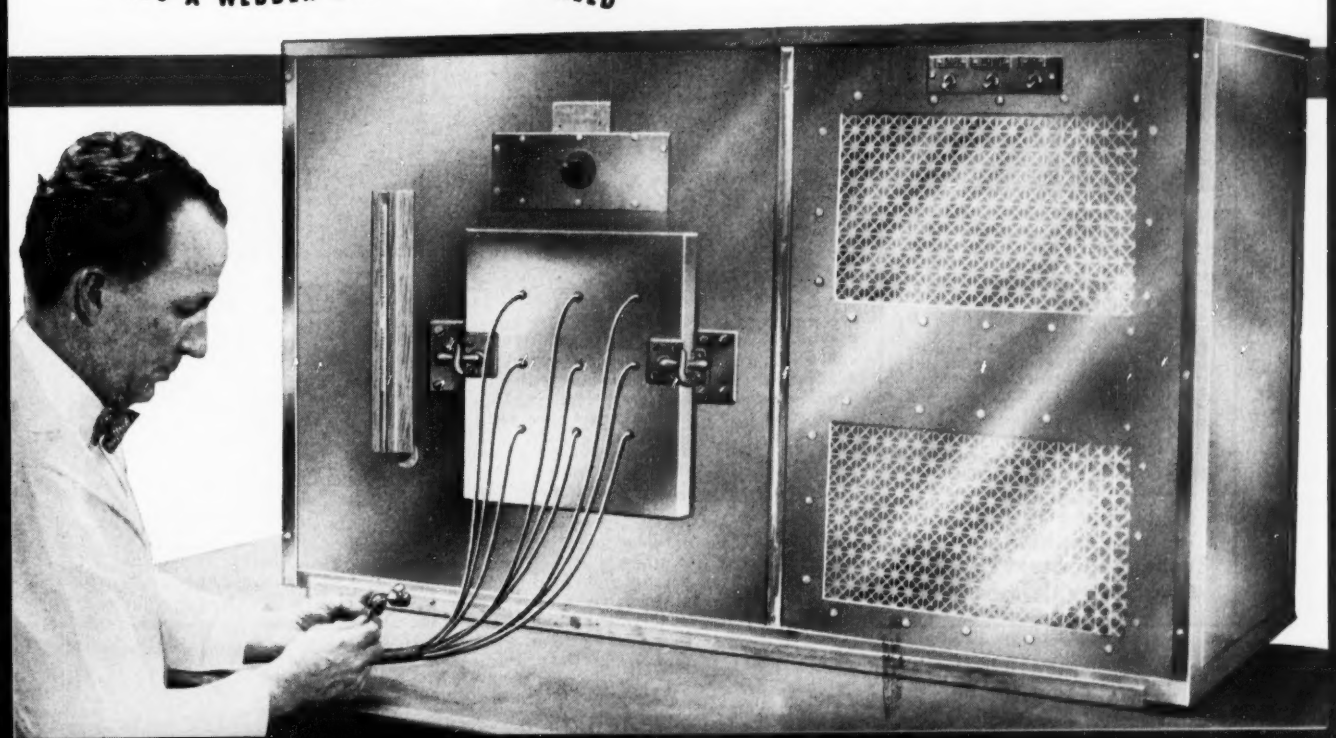
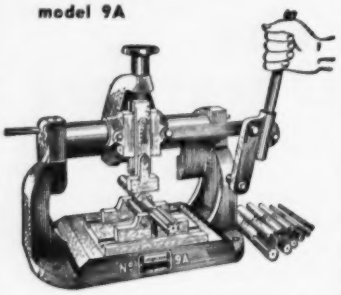


EVERY SHOP

NEEDS THIS MARKING MACHINE

model 9A



This widely adaptable hand machine also comes in air and motor driven models. It's for marking tools and parts of steel, all metals and plastics. It marks rounds with a flat die—flats with a round die. Write now for full descriptive illustrated literature and prices.

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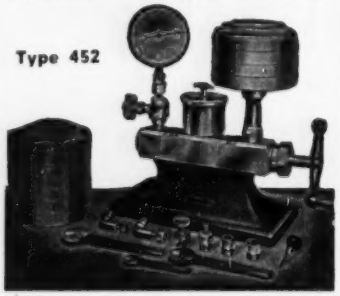
For more information circle 82 on inquiry card.

AMTHOR Dead Weight Pressure Gauge TESTER

Type 452



Modern design and construction puts this rugged precision instrument in a grade above the ordinary dead-weight testers.

Made in 14 ranges, to 10,000 lbs. maximum.

We guarantee 1/10 of 1 percent accuracy in each range.

The Type 452 is designed for simplicity and compactness. It incorporates the newest refinements and improvements. Adapters and tools are supplied, as well as either carrying case or protecting cover.

Immediate and intelligent attention will be given to your inquiries on all industrial speed measurement problems.

Drop us a line today.

Amthor Testing Instrument Co., Inc.

49a Van Sinderen Ave., Brooklyn, N.Y.

For more information circle 81 on inquiry card.

NEW INSTRUMENTS

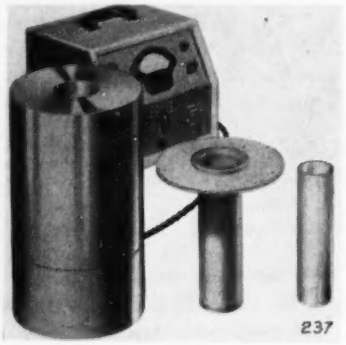
model) for freehand electrical marking on all steels, ferrous alloys, cast and wrought iron, have ten-station rotary switch and regulating knob to enable operator to make a light or bold mark at will.—*H. P. Preis Engraving Machine Co., Hillside, N. J.*

For more information circle 306 on inquiry card.

NUCLEONICS

Gamma-radiation Counter

New "Type GR" gamma radiation detector has sensitivity many times greater than conventional G-M counters: for I-131 between 40,000 and 50,000 cpm per microcurie of sample. Because of its cup-type construction, counter itself serves as a container for sample.—*Welch Allyn, Inc., Skaneateles Fall, N. Y.*



For more information circle 307 on inquiry card.

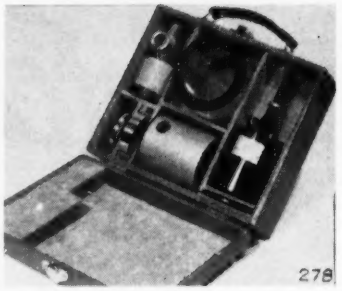
Roentgen-Meters

New roentgen meters are a refinement of manufacturer's midget type pocket chambers; are furnished in a complete set or separately. Set consists of three instruments of ranges 500 mr, 5 r and 50 r and a specially-adjusted "Model L-61 Charger-Reader."—*Landsverk Electrometer Co., 550 W. Garfield Ave., Glendale 4, Calif.*

For more information circle 308 on inquiry card.

Contamination Tester

New "Model L-75KA Analysis Unit Kit," for Civil Defense operations and general field use, quickly checks contamination of water and food supplies; is self-contained. Its sensitivity limit is 300 to 3000 times lower than

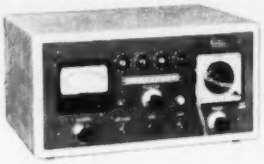


contamination limits set as safe on a 10-day and 30-day emergency basis by CDA. Measurements of good accuracy can therefore be made in a few seconds to a minute or two.—*Landsverk Electrometer Co., 550 W. Garfield Ave., Glendale 4, Calif.*

For more information circle 309 on inquiry card.

Automatic Scaler

New "SG-1A" general-purpose nuclear scaler features pre-set count (100 to 100,000) and pre-set time;

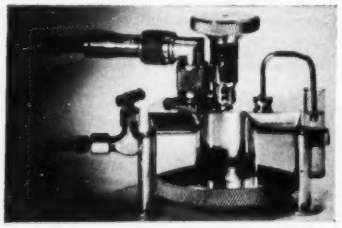


uses cold-cathode decade counting tubes for reliabilty. High-speed input decade scaling strip provides 5-usec. resolving time and a total scaling factor of 100,000. Maximum sensitivity of 20 mv. for alpha proportional, scintillation, or G. M. counting.—*George R. Utting Associates, 290 Centre St., Newton 58, Mass.*

For more information circle 310 on inquiry card.

Preflush Flow Counter

New "Model 21 'G-P' Preflush Flow Counter" is a low-background three-position windowless counter operating



with equal efficiency in both Geiger and proportional regions. Sample platform contains three recesses: for loading, for preflushing, and for counting. Preflush time is eliminated and operational time saved.—*Instruments & Equipment, Inc., 489 Fifth Avenue, New York 17, N. Y.*

For more information circle 311 on inquiry card.

Shielding Container

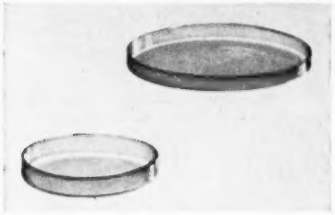
New "E-33" three-curie high-intensity shielding container, for shipping and storage of Cobalt-60 radiography or other sources, has 4.75 in. of lead plus 0.37 in. of malleable iron outer case; is nearly spherical in shape. A pie-shaped hinged cover section al-

lows access to source in center and protects radiographer from direct gamma rays. Shipping weight 295 lbs.—*Tracerlab Inc.*, 130 *High St., Boston* 10, *Mass.*

For more information circle 312 on inquiry card.

Disposable Plastic Cups

New plastic cups for measurement of radioactive samples are priced low enough to permit them to be disposed



of after use. Another advantage is that liquid samples can be dried slowly under heat lamps without distorting plastic cup, thus assuring quantitative measurement of dried samples. Cups are suitable for use with solutions containing weak acids or bases. Various sizes available.—*Falge Engineering Corp.*, 4733 *Elm Street, Bethesda* 14, *Maryland.*

For more information circle 313 on inquiry card.

PNEUMATICS

Elbow Tube Fittings

New long and extra-long male elbows have been added to maker's line of "Triple-lok" industrial tube fittings. Standard stock is steel, but new shapes are available, on special order, in brass, 316 stainless steel, and aluminum. Fittings as purchased include body nut and sleeve.—*Parker Appliance Co.*, 17325 *Euclid Avenue, Cleveland, Ohio.*

For more information circle 314 on inquiry card.

Compressed-air Purifier

New water-cooled aftercooler, for removing oil and moisture from compressed-air systems from 100 to 500 cfm., supplements maker's line of smaller-capacity aftercoolers. Use of longitudinal inner-fins is said to permit maximum heat transfer with minimum pressure drop; makes for a more compact design than was previously possible.—*The Heat-X-Changer Co., Brewster, N. Y.*

For more information circle 315 on inquiry card.

Air Purifier

New "Ultra-Aire" dry filtering medium removes particles as fine as tobacco smoke (0.05-0.10 micron). Life: on industrial city air, a stand-

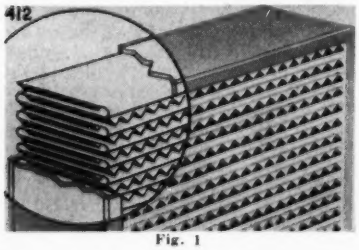
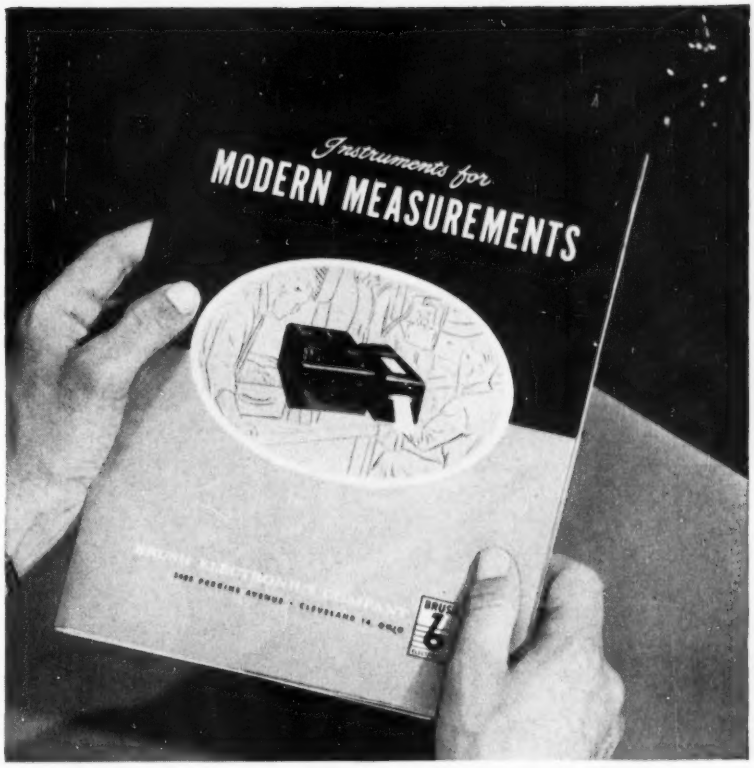


Fig. 1



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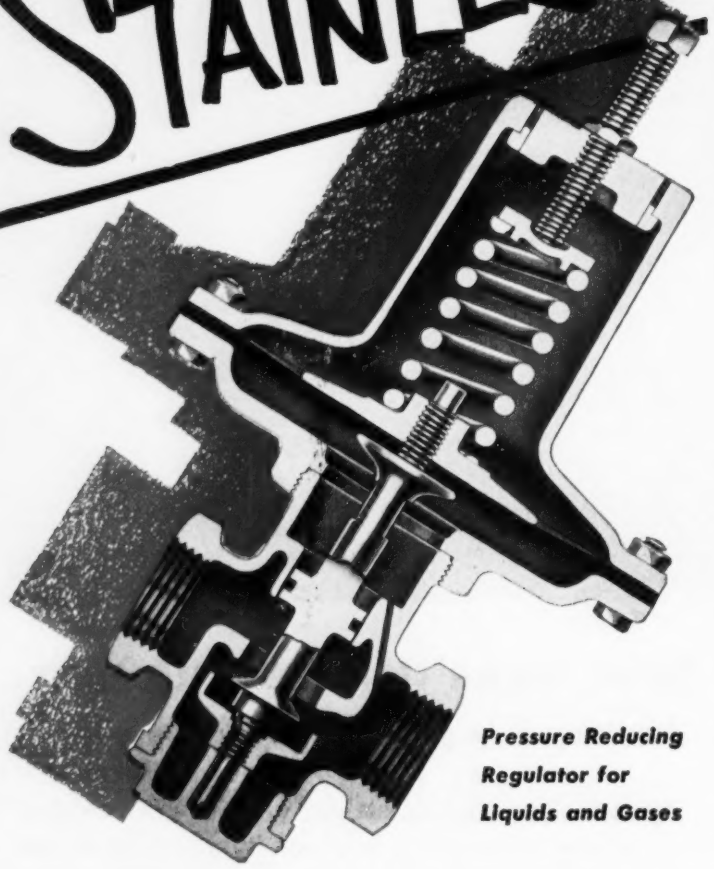
For more information circle 84 on inquiry card.

STAINLESS



Pressure Reducing Regulator for Liquids and Gases

For regulation of fluids where corrosion and contamination are problems, Foster Automatic Valves are now available in all-stainless construction.

All valve parts in contact with fluids may be had in a wide range of corrosion resisting alloys.

The next time you need dependable, trouble-free regulation, it will pay you to tell your Foster Representative your requirements.

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For more information circle 85 on inquiry card.

NEW INSTRUMENTS

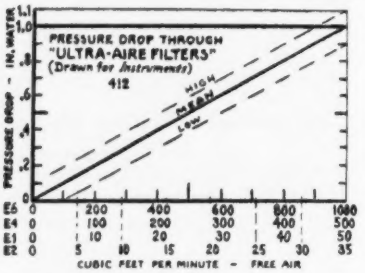


Fig. 2

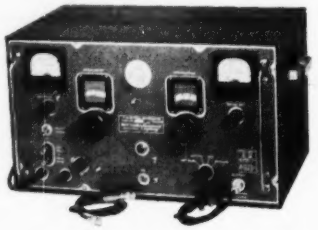
ard 1000-cfm. unit operated at full capacity 24 hours a day before its resistance increased from 1 to 2 in. water.—*Mine Safety Appliances Co., Pittsburgh 8, Pa.*

For more information circle 316 on inquiry card.

ELECTRICAL INSTRUMENTS

Signal Generator

New "Model 100C" FM signal generator, for 25-to-216-Mc. range, utilizes a novel r-f. circuit; tests band-

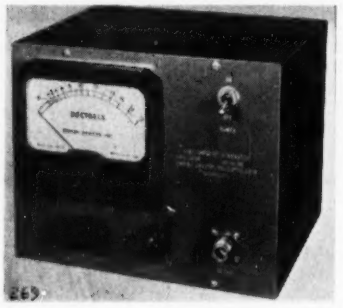


width, alignment and sensitivity of FM receivers; features exceptionally low drift.—*New London Instrument Co., P. O. Box* 189, *New London, Conn.*

For more information circle 317 on inquiry card.

UHF Pulse Generator

New "Model IG-115 Impulse Generator" for frequencies from 10 kc. to 1000 Mc. is recommended for use as

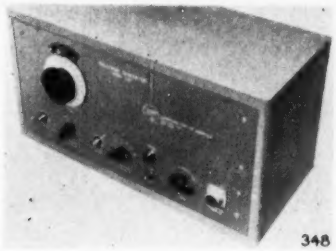


a calibrating standard on noise and field-intensity meters, as a signal source for broad-band distributed amplifiers, for transient response studies, etc. Pulse width 0.0005 microsecond; output 70,000 microvolts per Mc. bandwidth, adjustable over 70-db range; output impedance 50 ohms.—*Empire Devices Products Corp.,* 38-15 *Bell Boulevard, Bayside* 61, *N. Y.*

For more information circle 318 on inquiry card.

Spectrum Generator

New "Model 1232-B Spectrum Generator Secondary Frequency Standard" produces a crystal-controlled spectrum of harmonically-related fre-



348

quencies; envelope of harmonic amplitudes uniform from 1 kc. to 85 Mc. Useful frequency range 1 kc. to 1,000 Mc.; interval spacings 1, 2, 5, 10, 50 and 100 kc. Accuracy and stability: 0.0005 percent absolute accuracy during any 24-hour period after adjustment.—*Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y.*

For more information circle **319** on inquiry card.

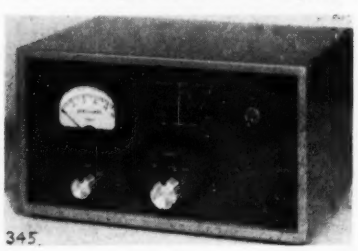
Square-pulse Generators

New "Model 100" (single-pulse output) and "Model 200" (double-pulse output) square-pulse generators utilize a new method of pulse shaping said to provide practically ideal square pulses of millimicrosecond rise time and widths from one millimicrosecond to several microseconds.—*Electrical and Physical Instrument Corp., 25 W. 43rd St., New York 36, N. Y.*

For more information circle **320** on inquiry card.

Random Noise Generator

New "Type 811-A" random noise generator provides entirely random noise with good Gaussian amplitude



345

distribution. Three ranges: in AF and RF ranges, noise is "white" with a uniform frequency spectrum having equal power in equal bands; in ASA range, a noise is generated meeting ASA standard Z24.3-1944.—*Hermon Hosmer Scott, Inc., 385 Putnam Ave., Cambridge 39, Mass.*

For more information circle **321** on inquiry card.

Phase-sequence Indicators

New phase-sequence indicating units combine functions of pilot light and PSI for 3-phase equipment. Connection through standard 3-pin plug; adapters available to convert exist-

365

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A manufacturer's reputation and that of his products are often determined by the performance of relays. Little wonder that more and more design engineers and manufacturers are specifying the "Diamond Seal for Diamond Quality" . . . Automatic Electric Manufacturing Company's Relays.

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For more information circle **86** on inquiry card.

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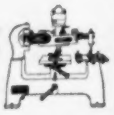

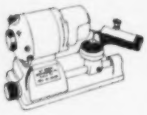

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116 Vista Avenue Pasadena 8, Calif.

For more information circle **88** on inquiry card.

ing pilot-light assemblies into PSIs. Two units are available: for 60-cps. and for 400-cps., each for 110, 220 or 440-v. operation with standard or dimmer type lenses.—*Brunswick Instruments, 29 Cleremont Ave., New Brunswick, N. J.*

For more information circle **322** on inquiry card.

Volt-ohm-milliammeter

New "Model 262" volt-ohm-milliammeter features 33 ranges; sensitivity of 20,000 ohms per volt d.c., 5,000

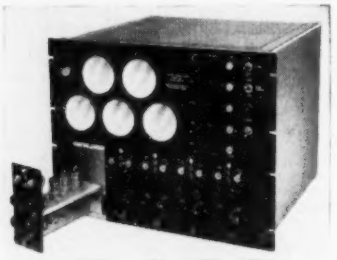
251

ohms per volt a.c.; accuracy: d.c. 3 percent and a.c. 5 percent of full-scale deflection. Maker's "Adjust-A-View" handle may be used to support instrument at a convenient viewing angle.—*Simpson Electric Co., 5200 W. Kinzie St., Chicago 44, Ill.*

For more information circle **323** on inquiry card.

Five-channel Oscilloscope

New five-channel oscilloscope, designed for bench use or relay rack mounting, permits measurement of

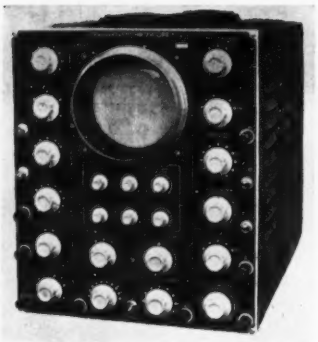


mechanical vibrations up to 100,000 cps. with flat response to 50,000 cps. Prime feature is interchangeability of five well-ventilated plug-in amplifiers. CR tube arrangement permits direct comparison of five simultaneous vibrational effects and photographic recording on a single 35-mm. film. A neon marker light provides a time base reference.—*Franklin Electronics, Inc., 415 West Pike St., Philadelphia 40, Pa.*

For more information circle **324** on inquiry card.

Oscillosynchroscope

New "Model OL-23 Oscillosynchroscope" features 4000 volts accelerating potential; vertical amplifier bandwidth flat from 5 cps. to 10 Mc.; sensitivity of 0.15 volts peak-to-peak per inch; and triggered or recurrent sweeps from 0.1 usec./cm. to 0.011

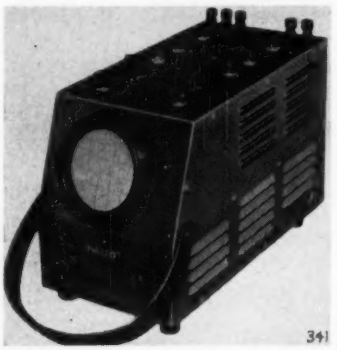


sec./cm. Video delay line permits observation of rising wavefront of pulses. Built-in generator produces output triggers from 50 to 5000 pps.; continuously-variable delay circuit allows sweep to be delayed from triggering source by 5 to 10,000 usec. under any triggered condition. Synchronization of recurrent, triggered, or delayed triggered sweeps may be from any waveshape.—*Browning Laboratories, Inc., Winchester, Mass.*

For more information circle **325** on inquiry card.

Cathode-ray Oscilloscope

New "Model S 8200" three-inch wide-response oscilloscope is said to be ideal for TV. Among claimed ad-



341

vantages: Excellent frequency response makes unit ideal for sync circuit trouble shooting; preset frequencies at vertical and horizontal rates take guesswork out of trouble-shooting sweep circuit; d-c. coupled amplifier circuits make video circuit trouble-shooting realistic; scope may be used as external indicator for sweep generator work (owing to incorporated phasing control), also as a high-sensitivity VTVM.—*Philco Corp., Philadelphia 34, Pa.*

For more information circle **326** on inquiry card.

Microwave Calorimeter

New portable microwave calorimeter, for medical and industrial use, has been priced to sell at one-third to one-ninth of usual price of "the standard product." It weighs 75 lbs. compared with more than 200 lbs. for maker's standard calorimeter.—*Sightmaster Corp., New Rochelle, N. Y.*

For more informtaion circle **327** on inquiry card.

Receiving-tube Tester

New "Model 1000 Plate Conductance Tube Tester" features fast testing with convenient ohms readings for leakage and shorts. Dial indicates

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Operating on the unique paramagnetic (attracted into a magnetic field) property of oxygen, these instruments provide many unique advantages . . .

SELECTIVITY:

Highly sensitive to oxygen. Effects of gases other than oxygen are negligible.

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Full scale ranges from 0-1000 PPM or up to 0-100% O_2 available. Combustion ranges 0-5, 0-10, 0-15% O_2 supplied with 0-25% O_2 air check range. Multi-range instruments available.

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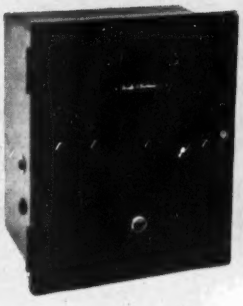
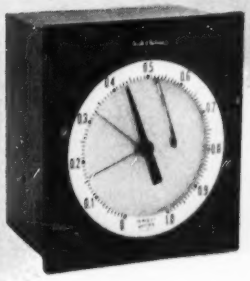
Model C

Model E-2

Model F-3

Model G-2





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There are many reasons why Industry specifies ADVANCE RELAYS: They meet or surpass Military and Civilian requirements—many types have AN approval—many are hermetically sealed—all are lightweight—small—rugged—compact—and all are precision-built for efficient, trouble-free, long life performance.

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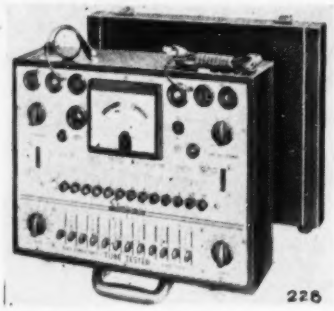
NEW INSTRUMENTS



percentage of rated plate conductance, which is closely related to mutual conductance. The tests are made under conditions simulating actual use. —*Simpson Electric Co.*, 5216 *Kinzie St., Chicago, Ill.*

For more information circle 328 on inquiry card.

Tube Tester

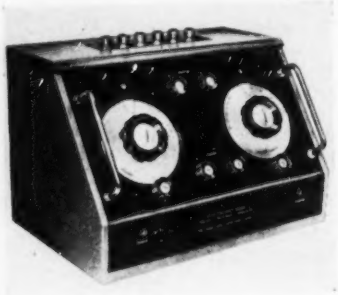
New "Model 7052 Mutual Conductance Tube Checker" permits, by means of transconductance checks,

true dynamic characteristics of all type of tubes to be accurately checked. Shorts on tube elements can be determined; tube-life can be accurately predicted; gain characteristics can be measured.—*Philco Corp., Philadelphia 34, Pa.*

For more information circle 329 on inquiry card.

Radiofrequency Bridge

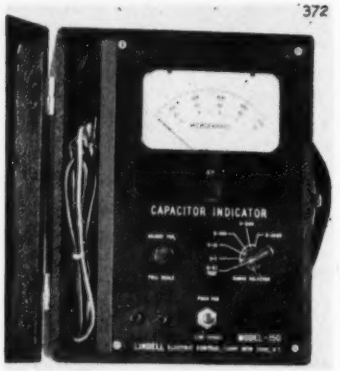
New "Type B601 Wayne-Kerr RF Bridge" measures balance and unbalance complex impedances, and impedance between any pair of terminals in a three-terminal network; employs tapped-transformer principle; reads directly, with 1-percent accuracy, resistances from 10 ohms to 10 megohms, capacitances from 0.1 uuf. to 20,000 uuf., and inductances from 0.5 uh. to 0.05 h., in frequency range 15 kc. to 5 Mc.—*Dep't IM, Marconi Instruments, Ltd.*, 23 *Beaver St., New York 4, N. Y.*



For more information circle 330 on inquiry card.

Capacitor Tester

New "Model 150 Capacitor Indicator" is designed to save man-hours in production, repair and maintenance

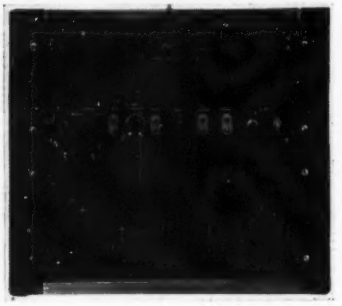


by indicating (1) rating of any capacitor, (2) whether capacitor is shorted, (3) whether capacitor is open. It operates on 115 v.ac. and weighs 5 lbs. —*Lindell Electric Control Corp.*, 57 *Lispenard St., New York 13, N. Y.*

For more information circle 331 on inquiry card.

Transient Recorder

New "Type 103 Magnetic Transient Recorder" permits one-shot or irregular-frequency phenomena containing



components from d.c. to 30 kc. to be recorded and displayed on a 'scope. Low-frequency characteristics make possible faithful reproduction of square waveforms with duration periods as long as 20,000 microseconds. —*Magne-Pulse Corp.*, 140 *Nassau St., New York 38, N. Y.*

For more information circle 332 on inquiry card.

Serviceman's Tester

New "Model 207 Tube-Battery-Ohm Capacity Tester" features a 7.5-in. easy-to-read indicator for counter use; gives direct readings for all tubes through emission method of testing; features four-position lever type switches; is housed in hand-rubbed oak carrying case with removable hinge cover.—*Electronic Measurements Corp.*, 280 *Lafayette St., New York, N. Y.*

For more information circle 333 on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

Transformer Panels

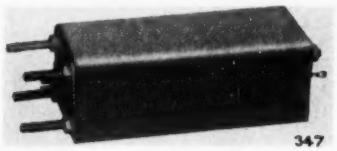
New "Series 303" transformer panels, used with "Series 300" variable electronic filters when a 600-ohm

impedance is required, can also be used when it is necessary to go from a 10,000-ohm impedance to a 600-ohm impedance. Transformers are arranged to provide grounded, "floating," or balanced connections. Three models: "303A" provides one 600-ohm output; "303B" provides two 600-ohm outputs; "303C" provides two 600-ohm inputs and two 600-ohm outputs.—*Spencer-Kennedy Laboratories, Inc., 186 Massachusetts Ave., Cambridge 39, Mass.*

For more information circle **334** on inquiry card.

L-f. Preamplifier

New "Model 1322" preamplifier provides initial amplification for signals at sub-audio and audio frequencies

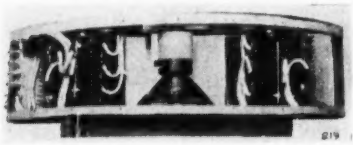


from extremely low input levels. Bandwidth (down 3 db) with source impedance 100,000 ohms or less is 0.5 to 10,000 cps; with source impedance of 1 meg, bandwidth (down 3 db) is 0.5 to approximately 3,000 cps.—*Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y.*

For more information circle **335** on inquiry card.

Airborne Transformer-rectifier Units

New airborne transformer-rectifier units for 28-volt aircraft d-c. power systems have current ratings up to 200 amps.; meet environmental and



electrical MIL specs and effect savings in weight, space and efficiency as compared with d-c. generators.—*Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.*

For more information circle **336** on inquiry card.

Test Adapters

New "SH29" 9-pin Miniature Test Adapter and "SH28" 8-pin Octal Test Adapter are added to maker's 7-pin test adapters, so that now servicemen can test all sockets "topside."—*CBS-Hytron Div., Danvers, Mass.*

For more information circle **337** on inquiry card.

Step-variable Delay Line

New "Type 702" step-variable delay line is a bilaterel linear network capable of producing variable time delay

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*Instrument Quality

There is one characteristic common to all Giannini instruments—they are built to rigid, instrument-quality standards. They are instruments with an earned reputation of offering the utmost in mechanical and electrical fineness—resulting from outstanding craftsmanship and rigorous calibration, testing and inspection procedures. Your job requirements can be met or exceeded by Giannini IQ instruments.

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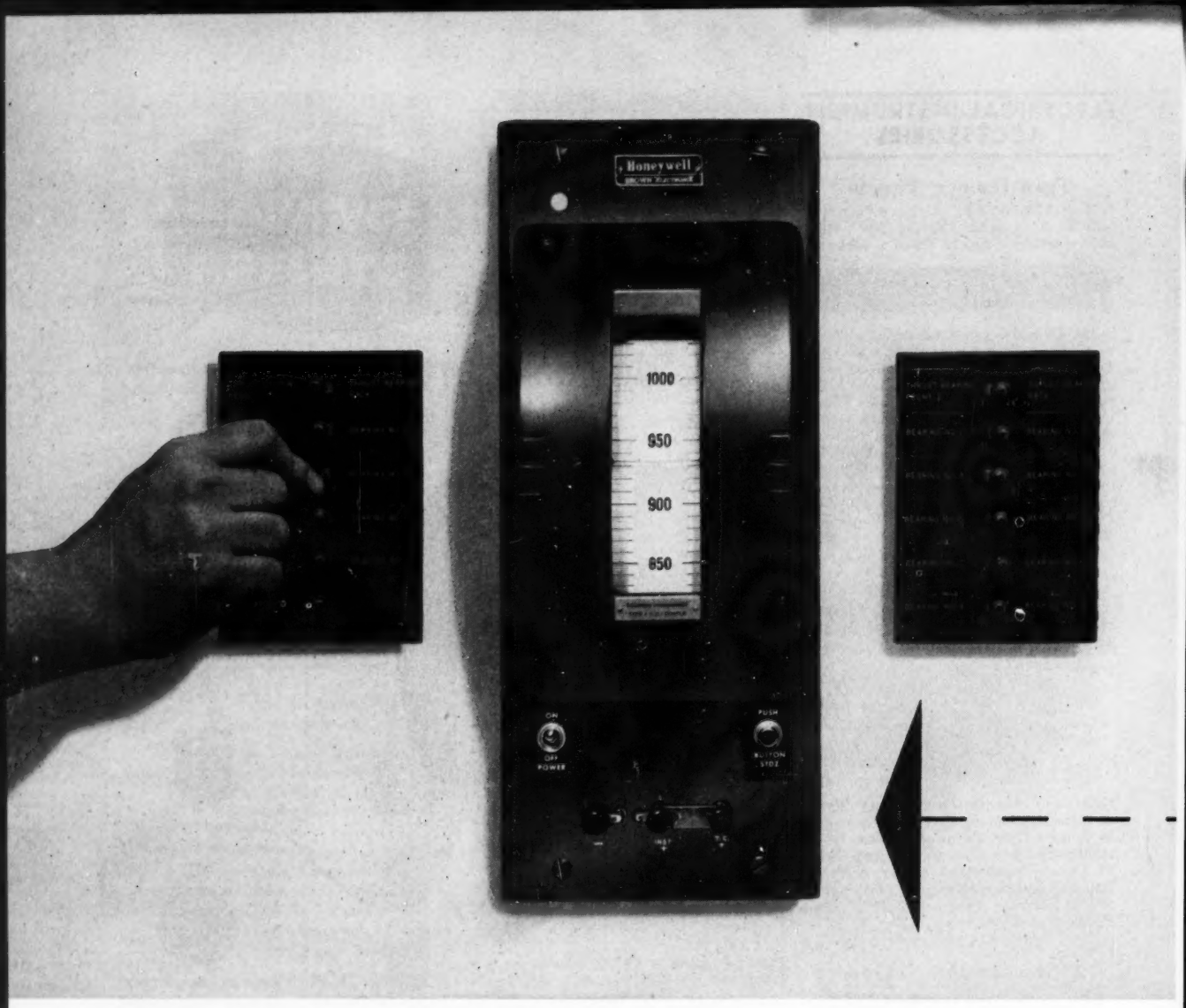

Look at these features!

compact case
approximately 6½ inches wide by 15⅜ inches high

easily-read drum scale
rotates vertically; graduated length 28⅝ inches provides big, legible scale divisions and numerals.

accurate hairline index
eliminates parallax errors, permits high readability.

fast measurement
full scale rotation in 4½ or 12 seconds for 60-cycle operation.

external key switches
can be located at the side of the indicator (as shown), below or above—wherever most convenient for the particular panel layout.

large number of points
additional key switch banks provide any desired number of temperature points. Legend plates facilitate identification.

high precision
calibrated accuracy is 0.2% of scale span.

variety of ranges
supplied for use with either thermocouples or resistance thermometers, in a selection of ranges applicable to power plant temperatures.

Squeezed for panel space?

THIS NEW

Honeywell temperature indicator

needs no elbow room!

CROWDED PANELS are no problem for this new temperature instrument . . . the Vertical Scale Precision Indicator. Its slender, compact case makes it a natural for graphic panels—and a readily-inserted, space-saving member of conventional generator and turbine boards.

Basically, it's the same *ElectroniK* Precision Indicator which the power industry and many others have used and relied upon for many years. But, its outside appearance has changed: it's a completely new design that places the bulk of the instrument mechanism *behind* the panel . . . uses the valuable front-of-panel space primarily for the indicating scale.

Equipped with key switch banks, the Vertical Scale Precision Indicator offers a fast, convenient way to spot-check temperatures in bearings, pumps, hydraulic couplings, motors and other potential hot spots.

Your local Honeywell engineering representative will be glad to discuss how this new instrument can save space on the new panels which you may be planning. Call him today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4482 Wayne Ave., Philadelphia 44, Pa.

● **REFERENCE DATA: Write for new Bulletin No. 1541 on the Vertical Scale Precision Indicator.**

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NEW INSTRUMENTS

up to 10 microseconds and having equal (190-ohm) input and output impedance. It consists of 55 sections of lumped-parameter *L-C* filter networks, each section designed to give (1) linear phase shift up to 70 percent of its cutoff frequency, and (2) a Gaussian frequency-response curve. As a result, unit produces essentially zero overshoot and has rapid rise time (less than 0.45 usec. at any step). Nominal cutoff frequency is 1.27 Mc.—*Advance Electronics Co., P. O. Box 394, Passaic, N. J.*

For more information circle **338** on inquiry card.

Anti-harmonics Filters

New "Type DE" filters eliminate harmonic frequencies from second to eighth by a minimum of 60 db; are so designed that a 3 percent drift in frequency of signal source will not affect filtering action; are available in a variety of impedances; can be made for any frequency from 20 cps. to 20 kc.; can be made for use in balanced or unbalanced circuits.—*Ortho Filter Corp., 196 Albion Ave., Paterson, N. J.*

For more information circle **339** on inquiry card.

Regulated Power Supply

New "Model 150" voltage-regulated power supply has d-c. output voltage continuously variable from 0 to 150

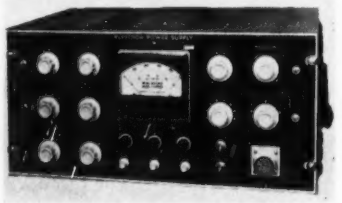
276

volts and delivers from 0 to 50 ma. In range 20-150 volts, output voltage variation is less than 0.5 percent for line fluctuation from 105 to 125 volts and no-load to full-load current. Ripple voltage is less than 5 millivolts. —*Kepco Labs., 131-38 Sanford Ave., Flushing 55, N. Y.*

For more information circle **340** on inquiry card.

Klystron Power Supply

New "Model TVN-11" klystron power supply supplies beam, reflector, filament, and modulation voltages for



operation of low-power reflex microwave oscillator tubes. Beam voltage continuously variable from 225 to 500 volts; reflector voltage continuously variable from 25 to 875 volts; ripple content under 2:5 millivolts; regulation better than 1 percent.—*Browning Laboratories, Inc., 750 Main Street, Winchester, Mass.*

For more information circle **341** on inquiry card.

H-v. R-f. Power Supplies

Four new models of maker's high-voltage r-f. power supplies are unusual in that they may be reversed in polarity by a front-panel lever: useful where data are needed for both positive-ground and negative-ground hook-ups, where quick reversing in polarity is desirable in kv. range, etc. —*Neutronic Associates, 83-56 Vietor Avenue, Elmhurst 73, N. Y.*

For more information circle **342** on inquiry card.

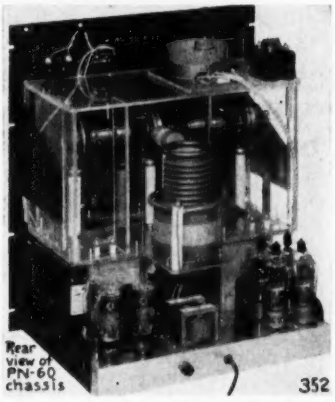
Variable D-c. Supply

New "Model SR2 Nobatron-Ranger" wide-range variable d-c. supply converts nominal 115 v.ac. line to regulated d.c. of 100-300 volts at 1-10 amps. Output regulation is 0.25 percent at any voltage setting; ripple is 1 percent rms. maximum. Instrument is easily rolled or transported from one location to another.—*Sorensen & Co., Inc., 375 Faireld Ave., Stamford, Conn.*

For more information circle **343** on inquiry card.

H-v. D-c. Power Supplies

New "Models LAB-40 and PN-60" high-voltage supplies are announced. "LAB-40" features a continuously-variable regulated 25 to 40 kv. d-c.



power supply has a 4 to 6 kv. focus tap for use with flying spot kinescope recording tubes, etc., "PN-60" r-f. d-c. power supply is continuously variable from 0 to 60 kv. Polarity changes are made on front panel. Current output is 1 ma. at 60 kv.—*Spellman Television Co., Inc., 3029 Webster Ave., Bronx, New York City.*

For more information circle **344** on inquiry card.

Experimental Lumped-constant Delay Lines

New lumped-constant delay lines are laboratory-built to close tolerances in open-frame construction. Designers can test these lines in experimental equipment and determine final specs before quantities are ordered. Accessi-

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NEW ASCO CATALOG

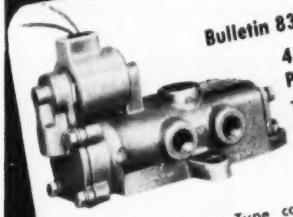
Describes Scores of Solenoid Valves

New Valve Catalog No. 24 brings you up-to-date on the extensive ASCO line of Solenoid Valves (list prices are included). New valves developed and put on the market recently are described in detail for the first time. A few of these are:

Bulletins 8262 and 8314
Midget Size
2 & 3-Way Packless Solenoid Valves

Midget Valves are now available with EXPLOSION-PROOF Solenoids for Class 1, Group D hazardous locations.

2-Way (Normally Open or Normally Closed) — Ports, 1/16" through 3/16"; pressures up to 1000 p.s.i. 3-Way — Ports, 3/64" and 3/32"; pressures up to 125 p.s.i. Time Delay Feature — Valves with 3½-6½ seconds delay also available.



Bulletin 8344
4-Way POPPET TYPE Packless Solenoid Valves

This valve has been thoroughly tested as a control unit in equipment requiring "plus" performance. Valve features:

Reliability — Poppet Type construction means this valve will not stick! Power stroke occurs in both directions — no spring return!

Fast Operation — 500 cycles/minute continuous duty; 750 cycles/minute intermittent duty (air).

Freedom in Mounting — Can be mounted in any position. Available 4 and 5 port; flow metering; standard or manifold mounting; ⅜, ½, ¾, and 1 inch pipe size. Handles air, water, or hydraulic oil; maximum pressure 250 p.s.i.

These two are just examples of new valve data. If you have any need for controlling the flow of liquids or gases in the equipment you are designing or operating, you should find this up-to-date ASCO Valve Catalog useful. Want a copy? Just drop us a note or call up and let us know. We'll be glad to send it to you . . . and extras for your associates if you desire.

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For more information circle **95** on inquiry card.

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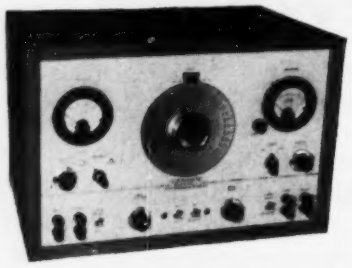

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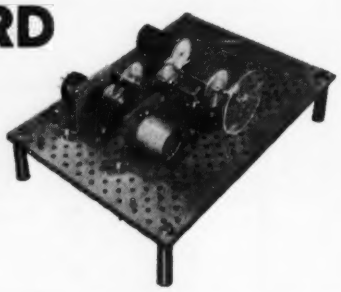

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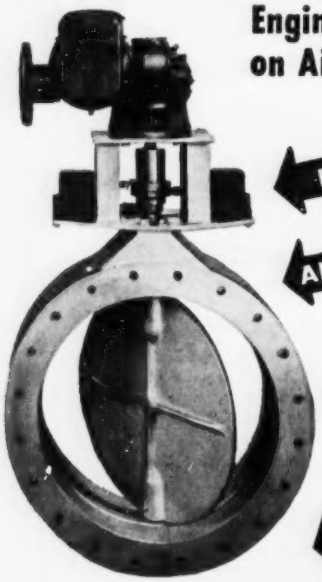
W. S. ROCKWELL VALVES

Engineered for Dependable Service on Air, Gases, Liquids, Semi-Solids



FULL FLOW with minimum pressure drop.

ANY CONDITIONS of commercial, drip- or bubble-tight closure, with quick, positive control and shut-off manually or automatically.

RESISTANT Made ruggedly for all conditions of corrosion, erosion, temperatures to 2000° F., pressures to 300 p.s.i.

ALL TYPES Butterfly, wafer or slide valves, 1" to 120" pipe size.

W. S. ROCKWELL COMPANY

ROCKWELL SINCE 1888 BUILT

BUTTERFLY VALVES • SLIDE VALVES • AUTOMATIC VALVES

2643 ELIOT STREET • FAIRFIELD, CONN.

Sales Representatives in Principal Cities

For more information circle 97 on inquiry card.

bility permits flexibility in choice of delay by tapping line.—*May Engineering Co., 6055 Lankershim Blvd., N. Hollywood, Calif.*

For more information circle 345 on inquiry card.

Variable Inductor

New "Model PA-63" electrically-variable inductor features a permanent magnet to provide a stable bias

flux in core, giving unit exceptional versatility and stability. Over most of its range, unit has Q of 115 to 130 and no sharp peaks and valleys. Manual adjustment of magnetic bias assures control over L-C ratio and permits operation at point of best linearity.—*Vari-L Co., Inc., Box 1433, Stamford, Conn.*

For more information circle 346 on inquiry card.

Constant-current Converter

New "Model CC-60 Constant Current Converter" converts a standard power supply into a constant-current generator for transistor and other applications requiring constant cur-

rent; is connected externally in series with standard supply: no rewiring or other modification. Design makes use of high impedance of a pentode when operating above knee of I_B-E_B curve to present a constant impedance to input voltage source. Inverse current feedback further increases internal impedance and provides for long-term current stability. Output constant current is continuously adjustable from zero to 50 ma., its variation within 2 percent for output voltage variation of zero to 150 volts.—*Electronic Research Associates, Inc., Box 29, Caldwell, N. J.*

For more information circle 347 on inquiry card.

Wave-guide Attenuator

New "Model X382A" wave-guide attenuator gives direct readings, from zero to 50 db, that are completely

independent of frequency. Phase shift is independent of attenuation setting and accuracy is within 2 percent of decibel reading. Attenuator requires no interpolation or charts. Design is unique in that attenuation depends on angular position of attenuating film rather than its specific resistivity. Frequency range 8200 to 12,400 Mc. —*Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.*

For more information circle **348** on inquiry card.

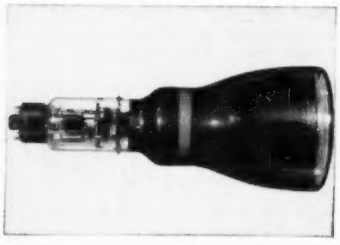
UHF Dummy Load

New "V-4042 High-Power Water Load" permits accurate measurement of power up to 15 kw. in UHF TV band. Accuracy is better than 2 percent; VSWR less than 1.15. Input connector is a UHF flange which mates with standard 3⅛-in. 50-ohm coaxial line. Body diameter 3⅛ in.; length 7 ft.; weight 35 lbs. Power is measured by measuring temperature rise of water passing through dummy load. A 3-gpm. water supply and a water flow-rate meter are required.—*Varian Associates, San Carlos, Calif.*

For more information circle **349** on inquiry card.

7-inch 2-gun C.R. Tube

New "Type 72RA" two-gun 7-in. cathode-ray tube, similar in many respects to "5S" tube of RTMA type,

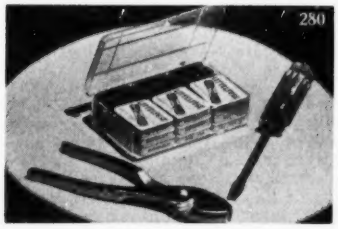


is designed for use in dual-channel 'scopes having high sensitivity.—*Electronic Tube Corp., 1200 E. Mermaid Lane, Philadelphia 18, Pa.*

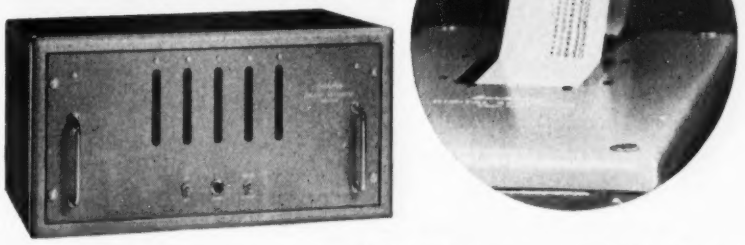
For more information circle **350** on inquiry card.

Fuse Kit

New version of "One Call Kit" for TV service men and set manufacturers represents latest usages of fuses;



new Berkeley PRINTED READOUT for ELECTRONIC COUNTERS



✱ DIRECT READING ✱ RAPID CYCLING ✱ LOW COST

PRINTED READOUT for high speed electronic counters is now available at low cost as a standard BERKELEY product. This Digital Recorder provides a direct means of permanently recording sequential count information in arabic numeral form on a standard adding machine tape. It is designed to operate from electronic counters, Time Interval Meters, Events-per-Unit-Time Meters, nuclear scalers, and other electronic totalizing devices. Most standard BERKELEY instruments now in use can be readily adapted for operation with the BERKELEY Digital Recorder, thus eliminating the need for purchase of new counting equipment.

THE DIGITAL RECORDER . . . is composed of a Digital Scanner and a Digital Printer. The first unit consists of a bank of readout decimal counting units essentially paralleling the totalizing function of the basic counting instrument from which they operate, and a selecting relay matrix to channel information from the counting circuit to the Digital Printer. This second unit presents a sequence of total counts in direct reading digital form on a standard adding machine tape.

A COMPLETE SYSTEM . . . of Electronic Counter and Digital Recorder then consists of three elements: a suitable electronic counting device, Digital Scanner, and Digital Printer. The latter two elements comprise the complete Digital Recorder. Modification D, a standard modification of the system, will permit original count information to be channeled directly into the Digital Scanner, thus eliminating the need for a separate electronic counter.

SPECIFICATIONS . . . Minimum counting period determined by the characteristics of the basic counting instrument. Maximum cycling rate: 1 printout every ¾ second. Indicating capacities 3, 4, 5 or 6 columns. Digital Scanner—20¾" x 10½" x 15" cabinet, wt. 70 lbs., standard 19" relay rack panel. Digital Printer—7½" x 8¼" x 14½" cabinet, wt. 20 lbs. Price, Digital Recorder, Model R-3 (3-column), $1050; Model R-4 (4-column), $1125; Model R-5 (5-column), $1200; Model R-6S (6-column, 100 kc), $1275; Model R-6 (6-column, 1 mc) $1325. Modification D (not available on 1 mc unit) $145.00. Prices f.o.b. factory.

M-5

Please request Bulletin 608

Berkeley Scientific

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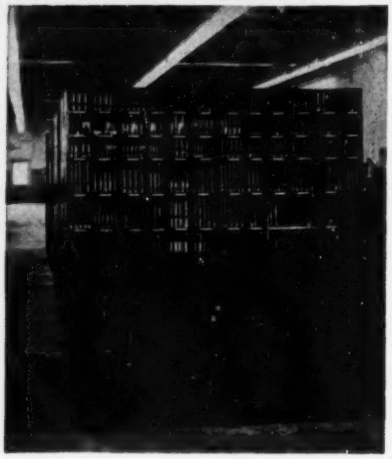
"DIRECT READING DIGITAL PRESENTATION OF INFORMATION"

For more information circle **98** on inquiry card.

AVAILABLE NOW! from Stock

TRINITY THERMOWELLS



—in a wide variety of designs, sizes and materials.

We will be glad to place your name on the list to receive copies of the monthly Trinity Thermowell Stock List.

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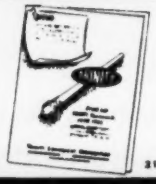


2106

TRINITY EQUIPMENT CORPORATION
494 Westfield Ave., East Roselle Park, New Jersey
THERMOWELLS and other Specialties for the Process Industries

For more information circle 99 on inquiry card.

RAHM Potentiometer TRANSDUCERS . . .

Typical Data

Linearity:
with pressure: ±0.25% to ±0.75%
with altitude: ±0.5% (0-70000 ft.)
Resolution: 0.15% to 0.4% of pressure.

Design Features

Operation from −60°C to +160°C and to 60G acceleration.
a-c or d-c output usable without amplification.

Special Features

Protection from corrosive media or atmosphere. Multiple output from single instrument. Output non-linear with pressure.

REQUEST BULLETIN A-452

FOR PRESSURE
ALTITUDE
AIR SPEED
ACCELERATION

RAHM INSTRUMENTS, INC.
12 WEST BROADWAY, N. Y. 7, N. Y.

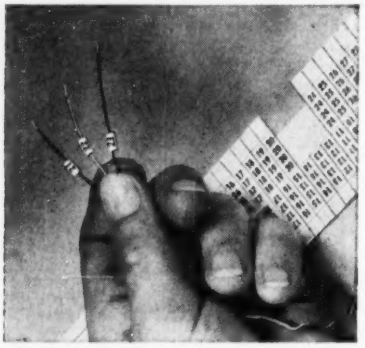
For more information circle 100 on inquiry card.

NEW INSTRUMENTS

enables service men to handle 95 percent of all their needs.—*Littelfuse, Inc., 1865 Miner St., Des Plaines, Ill.*
For more information circle 351 on inquiry card.

Small-gage-wire Markers

New small markers, designed especially for coding small-gage wires eliminate time-consuming method of

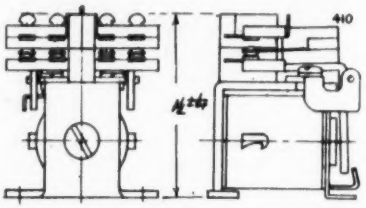


trimming large markers to size; are ¾ in. long, center die cut and mounted on a 2x10-in. backing card with "speed tab" arrangement whereby any code can be stripped off without disturbing remaining codes. Available in over 1000 codes including A. S. A. and NEMA specs; also made on special order.—*Westline Products Div., 600 East Second St., Los Angeles 54, Calif.*
For more information circle 352 on inquiry card.

ELECTROMECHANICAL COMPONENTS

Vibration-resistant Relay

New "Type AN-3304-1" 4-p.d-t. relay, designed mainly for 24-28 v.dc. service, meets 10-G 500-cps. vibration



spec.; weighs 0.125 lb. open and 0.225 lb. sealed. Pick-up voltage 18 v.dc. max., drop-out 7 to 1.5 v.dc., max. operating 29 v.dc. Rated load at 29 v.dc. 3 amp. (For 115-v. 400-cps. service, 3 amp. resistive, 1.5 amp. inductive, motor 1.5 amp.).—*United States Relay Co., 1744 Albion St., Los Angeles 31, Calif.*
For more information circle 353 on inquiry card.

Control-system Relay

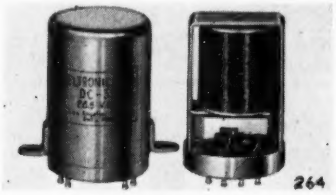
New "Electronic Resistance-sensitive Relay" can be varied by a stepless dial; may be used to start or stop a fractional-hp. motor directly when a contact-making ammeter, voltmeter, or wattmeter reaches set point; also for liquid-level control, sorting of small parts, etc. Contact rating: in-

rush 30 amps., carry 10 amps., break 10 amps. on n-c. contacts and 5 amps. on n-o. contacts. Break inductive load for 125 v.dc. 0.2 amps. n-o. and 0.1 n-c.—*Industrial Control Dep't, General Electric Co., Schenectady 5, N. Y.*

For more information circle 354 on inquiry card.

Shock-proof Relay

New "Type DC-33" hermetically-sealed miniature d-p.d-t. d-c. relay weighs 3.62 oz.; exceeds MIL-R-5757B



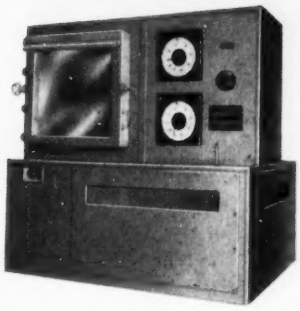
specs. Contact rating 2 amps.; required input coil power less than 0.325 watt; available in any coil resistance up to 25,000 ohms and with spade lugs, turret, or wire loop terminals. —*Deltronic Corp., 9010 Bellanca Ave., Los Angeles 45, Calif.*

For more information circle 355 on inquiry card.

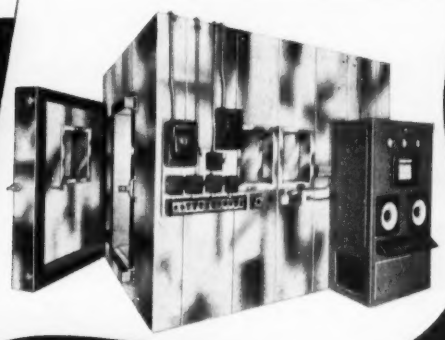
Synchronous Timing Motor

New "Model 50" synchronous timing motor has torque rating of 40 in.-oz. at 1 rpm.; features oil retaining disks so that oil cannot leak out of die-cast housing; 50 percent more bearing surface than previous motors of this type; and positive positioning and locking of stator and rotor assemblies. Available in unidirectional or reversible models in output speeds

Considering Environmental Test Equipment?



Be sure to look beyond the unit . . .



Bowser Technical Refrigeration pioneered the development and manufacture of environmental test equipment.

Bowser's complete engineering staff is available (at no obligation) to help in solving YOUR difficult test problems. Design engineers and production facilities are available to construct test equipment to meet your specialized requirements.

Typical of Bowser's standard test chambers are the Laboratory Unit and Walk-In Room shown above.

The Laboratory Unit has a temperature range from +200° F to −100° F, relative humidity range from 20% to 98%, altitude from sea level to 100,000 feet.

Standard Walk-In Rooms simultaneously produce altitude to 100,000 feet, temperature range from −100° F to +200° F, relative humidity from 20% to 98%.

Bowser also builds explosion chambers, sand and dust chambers, humidity simulation units, and environmental simulation chambers to meet any desired specifications.

Write for free descriptive bulletins or request a Bowser field engineer to consult on YOUR environmental test problem.

BTR

BOWSER TECHNICAL REFRIGERATION

DIVISION BOWSER INC. · TERRYVILLE CONNECTICUT

For more information circle 101 on inquiry card.

When your problem involves drying air to obtain more efficient, dependable instrument operation, the Industrol Dynamic Dehumidifier offers you a practical low cost solution.

Dryers are offered with manual, semi-automatic or fully automatic control. Heat regeneration of desiccant is supplied by either electricity or steam.

An Industrol Dynamic Dehumidifier used in conjunction with the Industrol Centrisorb Filter is the ideal combination to give you the clean, dry air that spells trouble-free instrument operation.

Prove to yourself why more plant operating men are specifying Industrol. A qualified engineer is available to consult with you on your dryer problems.

Send for Bulletin DD-150

2346

Industrol CORPORATION

Subsidiary of
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494 Westfield Ave., East • Roselle Park, New Jersey

For more information circle 102 on inquiry card.

Pneumatic Weight Transmitters

FOR LINEAR CONVERSION OF WEIGHT INTO POUNDS PER SQUARE INCH AIR PRESSURE

A complete line of weight transmitters in single and multiple diaphragm construction with load capacities up to 23,000 pounds per diaphragm. Pneumatic tare balance for any portion of the total load on all models. All moving parts are enclosed totally. Complete weighing systems designed to your requirements.

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JOHN R. MONSELL
Manufacturing Engineer
Pitman, N. J.

For more information circle 103 on inquiry card.

NEW INSTRUMENTS

from 1/6 rpm. to 1800 rpm. and for operating voltages from 6 to 550 v.ac.—*Hagen Mfg. Co., Moline, Ill.*

For more information circle 356 on inquiry card.

Midget Motors

New totally-enclosed explosion-proof d-c. aircraft motors, said to yield the highest horsepower-per-pound ratio consistent with reliability demanded of aircraft devices, are for applications requiring 5 to 45 watts output at speeds from 9500 to 15,000 rpm. Extremely fast-acting electromagnetic brakes are incorporated.—*Lear, Inc.*, 110 *Ionia Ave., N.W., Grand Rapids, Mich.*

For more information circle 357 on inquiry card.

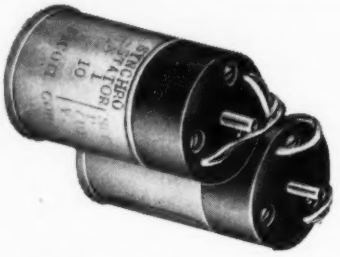
Instrument Servomotors

New "Models 1300 and 1500" low-inertia servomotors for servo and instrument applications are available for two-phases 60 to 400 cps. a.c. in 2-, 4-, 6- and 8-pole construction; can be supplied with high-impedance control winding for plate-to-plate operation. Precision low-backlash gearhead also is available.—*Induction Motors Corp.*, 55-15 37*th Avenue, Woodside* 77, *N. Y.*

For more information circle 358 on inquiry card.

400-cps. Synchros

New "Size 11" 400-cps. synchros measure 1.062 in. in diameter. Maximum error spread is 20 minutes for

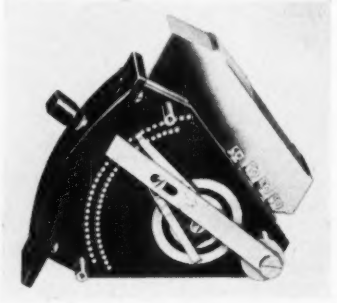


transmitters, control transformers, differentials and resolvers; 36 minutes for repeaters. Input voltage, current, and wattage vary with type of synchro, as does maximum output voltage.—*Transicoil Corp.*, 107 *Grand St., New York* 13, *N. Y.*

For more information circle 359 on inquiry card.

Lever-type Attenuators

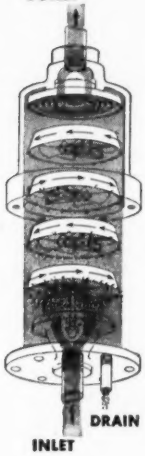
New "Series 820 & 830 Vertical Lever Type Attenuators" feature a baffle-plate covering front slot to pre-



EQUIPMENT LASTS LONGER
...PERFORMS BETTER...
when the

ARIDIFIER

SCRUBS, CLEANS AND DRIES
On Air and Gas Lines



LASTS LONGER because...
The Aridifier's patented centrifugal-baffle action traps 92% of all dirt, oil, scale and water in gas or compressed air . . . and drains off these troublemakers *before* they can damage tools and equipment.

PERFORMS BETTER because...
The Aridifier protects tools against the freezing, fouling, caking and corrosion caused by dirt and foreign matter . . . assures the clean, dry air and gas that means better spray work, painting, lacquering, sand blasting, air cleaning, and similar operations.

Easily installed, the Aridifier maintains itself. 10 models. Capacity range; 7 CFM to 17,000 CFM.

Learn HOW the Aridifier scrubs with a patented centrifugal-baffle action.
Write for This Catalog
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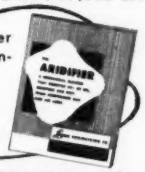


Logan ENGINEERING CO.
4921 W. Lawrence Ave., Chicago 30, Ill.

For more information circle **104** on inquiry card.

THE Model 10VA, shown, is one of eight models of All American Vibration Fatigue Testing Machines. The "10VA" produces vibration vertically in simple harmonic motion—from 10 to 55 cycles per second on automatic control and from 10 to 60 c.p.s. on manual control. Table load capacity 10 lbs. at 10g. Has 50% overload factor. Tests components, assemblies, products—exposes danger points—forestalls failures in the field. Simple to operate. Essential for today's inspection, testing, research. Send for Bulletin 551.
Manufacturers of All American Precision Die Filing Machines

ALL AMERICAN
Tool & Manufacturing Co.
8011 LAWNDALE AVENUE, SKOKIE, ILL.

For more information circle **105** on inquiry card.

vent extraneous matter from interfering with operation. Switch rotor is not attached to lever, can move freely by remote control. Up to eleven units can be mounted upon a standard 5¼x19-in. panel.—*Dep't LTA, The Daven Co., 191 Central Ave., Newark, N. J.*

For more information circle **360** on inquiry card.

Quick-disconnect Coupling

New quick-disconnect couplings, for coaxial cable applications, feature smallest size yet produced; Teflon insulators; compliance with all Government specs.—*Hallett Mfg. Co., 1601 W. Florence Ave., Inglewood, Calif.*

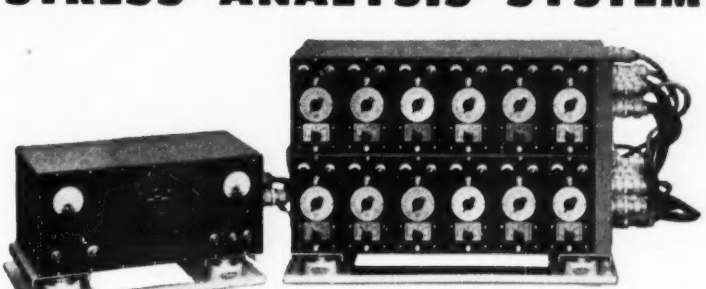
For more information circle **361** on inquiry card.

High-speed Commutator

New multi-channel rotary mechanical high-speed switching commutator, for telemetering, automatic rapid rate sampling, etc., features dust-proof construction and noise-free operation through service-life of at least 100 hours at 300 rpm.; and external adjustment for phase relationship between poles. Either break-before-make or m-b-b types can be supplied, with a maximum of 90 contacts on one pole and 30 on the other (two contacts

399

Century VIBRATION AND STRESS ANALYSIS SYSTEM



The Century Vibration and Stress Analysis System provides all of the necessary equipment to amplify and record vibration and stress-strain phenomena over a frequency range from 0 to 2000 cps.

Two modes of measurements are used in covering this system: (a) a carrier amplifier system to measure phenomena in the range of 0-500 cps, utilizing externally excited pick-ups as the sensing element; and (b) a linear-integrating amplifier system covering the range of 3-2000 cps, utilizing self-generating pick-ups, or d.c. excited strain gages employed dynamically. Both of these modes utilize either the Century Model 408 or 409 Oscillograph.

Write for Bulletins.

Century **GEOPHYSICAL CORPORATION**
TULSA, OKLAHOMA

4447 No. Bodine, Philadelphia 40, Pa. — 3406 W. Washington Blvd., Los Angeles 18, Calif. — 238 Lafayette St., Dayton 2, Ohio — 309 Browder St., Dallas, Texas — EXPORT OFFICE 149 Broadway, N. Y. City

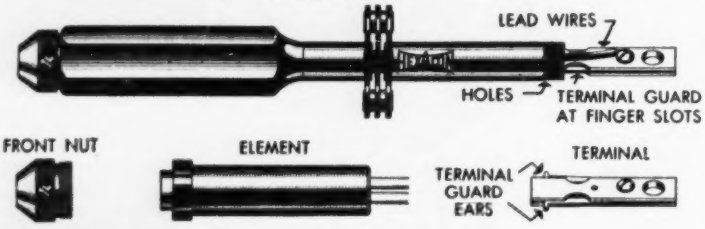
For more information circle **106** on inquiry card.

NOW! CHANGE SOLDERING IRON ELEMENTS IN A JIFFY!

—with HEXACON

*Patent Applied For

Readily Removable Terminal* does the trick!



ALSO NEW! BRASS-SHEATHED ELEMENTS
Easier to replace—Better Protection

Quick-change terminal can be removed in a second or two, permitting replacement of element in a fraction of the usual time. By simply depressing terminal guard at the finger slots, the terminal comes out in a jiffy—no longer necessary to fish element lead wires around terminal.

HEXACON—Industry's No. 1 Soldering Iron

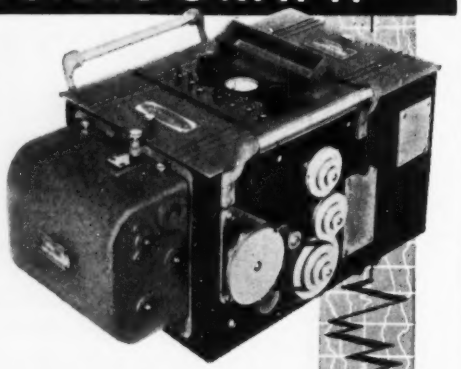
Write for catalog showing 40 industrial soldering irons of every type and size; there is no obligation.

HEXACON ELECTRIC COMPANY
179 W. CLAY AVE., ROSELLE PARK, NEW JERSEY

For more information circle 107 on inquiry card.

THE NEW 'Economy' OSCILLOGRAPH

Long the world's most popular oscillograph, the Type S-14 has been redesigned and improved to meet exacting demands of modern research. The NEW Type S-14C 'Economy' Oscillograph is the simplest to operate and maintain, and the most versatile in application. No research or testing laboratory is complete without it.



- Wide range of galvanometer types and characteristics. Natural frequencies to 10,000 cps; sensitivities to 50,000 mm per ma; single and polyphase watts.
- Precision optical system for very high writing speeds and high-quality records.
- Continuous-drive magazine for records to 100 or 200 feet long.
- Wide range of record speeds. Any of 9 speeds available by shifting single external belt. Standard speeds: 40, 20, 10, 4, 2, 1, 0.4, 0.2 and 0.1 in./sec.
- Internal motor and gear reducer shock mounted and vibrationless.
- Light-socket operation.
- Daylight loading and unloading.
- Automatic transiend recording attachments.
- Complete list of accessories for extreme versatility.

FOR FURTHER INFORMATION WRITE FOR BULLETIN 2B1-L

Hathaway INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

For more information circle 108 on inquiry card.

per terminal). Off period 1 deg. minimum on one pole, 3 deg. minimum on the other.—*G. M. Giannini & Co., Inc., P. O. Box N, Pasadena 1, Calif.*

For more information circle 362 on inquiry card.

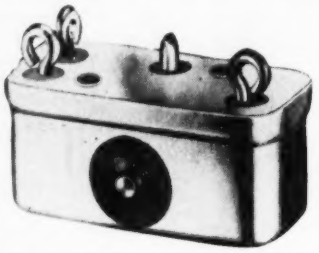
Snap-action Switches

Two new s-p.d-t. snap-action switches, designed for one-way actuation by cams, dogs or slides, have spring-loaded hinged roller-arm actuators; are listed by Underwriters Laboratories for 15 amp., 125, 250 or 460 v.ac., 0.5 amp. 125 v.dc., 0.25 amp. 250 v.dc. Operating force is in ounces; differential travel in thousandths of an inch.—*Micro Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.*

For more information circle 363 on inquiry card.

Sealed Snap Switches

New hermetically-sealed precision snap switches, said to represent two years' research, withstand 100 psi.



pressure, shock and vibration, and exposure to severe conditions. Work (product of force times distance) required to operate switch is approx. half amount required for standard "aircraft-quality" switches. Resistive ratings from 0 to 50,000 feet include 28 v.dc. 10 amp., 110 v.ac. 10 amp. from 60 to 400 cps. Minimum life of 100,000 operations at rated load.—*Haydon Switch Co., 232 No. Elm St., Waterbury, Conn.*

For more information circle 364 on inquiry card.

Limit Switch

New "IMLI-EI" explosion-proof heavy-duty limit switch, Underwriters' Laboratories listed for Class I, Group C and D, has operating head adjustable to any of four horizontal

ALINA movements
built for better service

Alina Chart Drive type 625

Generated Gears, Hardened, Polished Pinions, Sturdy Construction, High Torque Reserve. The product of over 100 years of manufacturing know-how. Designed and built to comply with S.A.M.A. specifications.

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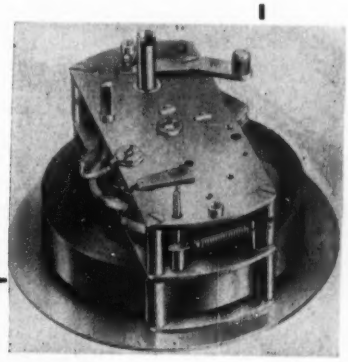
VISIT US at Booth 287 (6th Fl. Bal Tabarin Rm.) NAT'L INSTRUMENT CONFERENCE & EXHIBIT, Hotel Sherman, Chicago, Illinois



For more information circle 109 on inquiry card.

positions; reversible roller arm assembly; roller arm operable clockwise, counter-clockwise, or in both directions; actuator arm assembly adjustable through 360 deg.—*Micro Div., of Minneapolis-Honeywell Regulator Co., Freeport, Ill.*

For more information circle 365 on inquiry card.

ELECTRICAL AND ELECTRONIC COMPONENTS

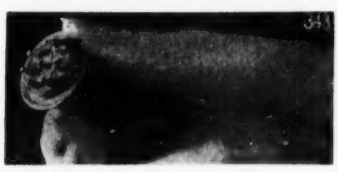
Evacuated Transistor

New evacuated junction transistors represent further improvement upon hermetic sealing of transistors. Announcement asserts that all polar molecules that in time might deposit themselves upon junction boundary line of these transistors are removed by evacuation process.—*Hytron Div., Columbia Broadcasting System, Danvers, Mass.*

For more information circle 366 on inquiry card.

Pulse Transformers

New "UX-7307A" and "UX-7350A" pulse transformers are hermetically-sealed MIL-T-27-type blocking oscillator transformers. Both have two windings for 1000-ohm impedance and two windings to match 250 ohms, but windings are arranged differently to cover a wide variety of applications.—*Raytheon Mfg. Co., 138 River St., Waltham 54, Mass.*



For more information circle 367 on inquiry card.

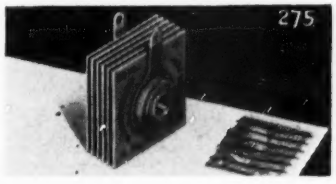
Filament Transformers

Ten new filament transformers for use with selenium rectifier applications are said to cover complete range of present requirements for rectifiers used in industrial, laboratory, TV and power applications.—*Merit Coil and Transformer Corp., 4427 N. Clark St., Chicago 40, Ill.*

For more information circle 368 on inquiry card.

Selenium Rectifiers

New line of selenium rectifiers, for use in radio, TV, TV boosters, and UHF converters, is said to be complete: fourteen units, rated for 130 volts rms. maximum input for load currents of 20 to 1000 ma. Unit shown in photo is 75-ma. "Type RS75E."—*International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.*



For more information circle 369 on inquiry card.

Rectifiers

New rectifiers feature absence of rotating windings, glass or metal tubes. No warm-up period required. Units in stock range from 3 to 50 kw., 125 or 230 volts d-c. output, fixed or variable voltage d-c. units to accommodate any a-c. voltage or frequency input. All are tested with a 200 percent overload.—*American Rectifier Corp., 95 Lafayette St., New York.*

For more information circle 370 on inquiry card.

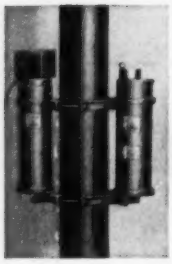
Non-linear Resistors

New varistors (non-linear resistors) have applications in circuits requiring sharp variation of resistance with applied voltage; are available in five cell sizes in a wide variety of enclosures; conform with MIL and JAN specs on humidity, shock, vibration, temperature cycling, solder pot, fungus resistance, etc.; have unusually low shunt capacitance; can be used effectively in RF circuits; response is instantaneous.—*International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.*

For more information circle 371 on inquiry card.

Subminiature Resistor

New "Type 1106" subminiature resistor (3/16 in. diameter x 7/16 in. long) has maximum resistance, wound with Evenohm, Karma, or equivalent, of 100,000 ohms; is rated at 0.10 watt. Other resistance wires with different temperature coefficients available with



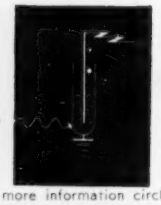
specific gravity

A new *standardized* series of instruments — the Ohmart Series SG Specific Gravity Meters* — utilizing radioactivity to continuously measure the specific gravity of liquids or other materials flowing through process vessels or piping. Measurements generally made with no direct contact with process materials or interference with process procedure.

SEE IT AT THE INSTRUMENT SHOW — BOOTH 252
HOTEL SHERMAN — CHICAGO — SEPT. 21-25

*Pat. Appl. For

Electricity From Radioactivity



the ohmart corp.

2347 Ferguson Rd., Cincinnati 38, Ohio
Chicago Dallas

For more information circle 110 on inquiry card.

FOR ALL-AROUND LABORATORY WORK *there are no finer presses than* WABASH

● Models from 3 Ton to 50

Precision construction, sturdiness, convenience and dependability are reasons for the popularity of Wabash hydraulic laboratory presses. With such quality features as chrome plated columns . . . precision bored guide holes . . . parallel platens sturdy hydraulic jacks and many others, they are outstanding in quality—yet reasonably priced.

USE THEM FOR . . .

- Plastic forming, molding
- Extrusion Tests
- Laminating
- Card & Badge Laminating
- Vulcanizing
- Transoptic Specimen mounting
- Briquetting
- Pressing out oils, waxes, etc.
- Embossing
- Compressiony testing
- Drawing and Forming
- Dehydrating
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- Crushing Tests
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The NEW 30 Ton Model

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For more information circle 111

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Electronic Circuitry for Instruments and Equipment

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The first book of its kind

A Complete home-study TEXT and COURSE, with 458 multiple-choice home-study test items on basic electronic circuitry for instruments, communications, TV, laboratory apparatus, and military equipment. (Printed serially in *Instruments* as "Instrument Electronics.")

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For more information circle 112

NEW INSTRUMENTS

less maximum resistance per spool. New resistor is impregnated against extreme humidity.—*The Daven Co., 191 Central Ave., Newark, N. J.*

For more information circle 372 on inquiry card.

Carbon Variable Resistors

New "Dual Carbon Control" with attached switch is added to "Type LC" line. For the first time, all three components are factory-assembled, available as a unit. "Type LC" controls, however, still may be ordered without switches, either single or dual types. —*P. R. Mallory & Co., Inc., 3029 E. Washinton St., Indianapolis 6, Ind.*

For more information circle 373 on inquiry card.

Subminiature Resistor

New "Type 16" 0.1-watt wirewound resistor measures 5/16 in. long by 17/64 in. diam., can be mounted either by its radial wire leads or by an axial #2 clearance hole through resistor's steatite bobbin; can be noninductively wound in all values up to 150,000 ohms. Standard tolerance is 1 percent; closer tolerances available. —*Shallcross Mfg. Co., Collingdale, Penna.*

For more information circle 374 on inquiry card.

Voltage-dividing Resistors

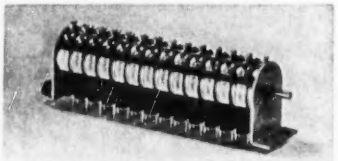
New "Type RTS-7/8" miniature wire-wound VDRs ("potentiometers") have same performance as "Type RT-

7/8" but have industry-accepted 1/4-in. shafts and ⅜-32 bushings. Power dissipation is 3 watts at 80 C. Units are 7/8 in. in diameter and 3/8 in. in depth, weigh 7/16 oz.—*Waters Manufacturing, Inc., 4 Gordon St., Waltham 54, Mass.*

For more information circle 375 on inquiry card.

Plug-in VDR

New "P-746" voltage-dividing resistor is a redesign of "Type 746" to incorporate a "plug-in" feature for aircraft fire control equipment. New

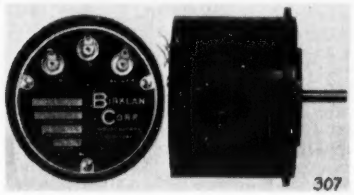


multi-gang units mount quickly and easily because only end plates are fastened: no wires to connect or solder. Up to twenty units on a single shaft.—*Fairchild Camera and Instrument Corp., Robbins Lane, Syosset, L. I., N. Y.*

For more information circle 376 on inquiry card.

High-precision VDRs

New "Series 3500 Potentiometers" are ten-turn voltage-dividing resistors wound with low-temperature-coefficient wire (0.002 percent per deg. C.) and thermally cycled to stabilize



resistance values of 500 to 300,000 ohms. Resolution can be as fine as 0.0024 percent. Linearity tolerance is 0.01 percent for entire 3600-deg. rotation. Each unit is calibrated against a 0.001-percent Standard and is accompanied by a continuous linearity curve.—*Birklan Corp.*, 200 *E. 3rd St. Mt. Vernon, N. Y.*

For more information circle **377** on inquiry card.

Long-life VDR

New "Type 756" voltage-dividing resistor has a service life of up to five million cycles with relatively no increase in noise level or change in linearity under normal operating conditions. Maximum resolution 0.05 percent; linear and non-linear construction to produce nearly all mathematical functions and many purely empirical functions; standard functional tolerances for linear windings as low as 0.25 percent; for non-linear windings 0.35 percent can be achieved with a 3:1 slope ratio in high resistance ranges.—*Fairchild Camera and Instrument Corp., Robbins Lane, Syosset, L. I., N. Y.*

For more information circle **378** on inquiry card.

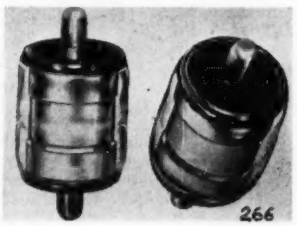
UHF Capacitors

New "Type GA" fixed composition capacitors in 39 new values have been added to maker's types. Complete range now includes forty-six RTMA preferred values from 0.10 mmf. to 10.0 mmf., in standard tolerances of 5, 10, and 20 percent.—*Electronic Components Div., Stackpole Carbon Co., St. Marys, Pa.*

For more information circle **379** on inquiry card.

Vacuum Capacitors

New miniature fixed vacuum capacitors, especially suited for aircraft, have practically loss-free characteristics; feature reversed copper-to-



Avoid conventional rat's nest wiring

ALDEN BACK CONNECTORS MODERNIZE YOUR PLUG-IN CHASSIS

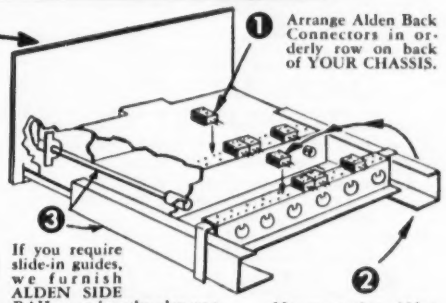
Possible to jump contacts because both sides are instantly accessible.

Critical voltages isolated by wide spacing.

Connectors are spread out in an orderly row, giving a central point of check where all leads are instantly accessible, identified by number and color-coding.

It's as easy as this

Modern design no longer tolerates "blind" connectors and congested rats-nest wiring. Use Alden Back Connectors to convert any chassis to plug-in, with 100% circuit accessibility. It's all done with STANDARD components—no design headaches, no waits, no procurement problems.

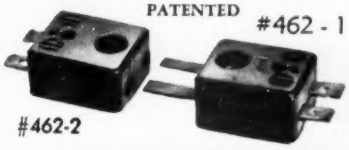


1 Arrange Alden Back Connectors in orderly row on back of YOUR CHASSIS.

2 Mount mating Alden Back Connectors on ALDEN LOCK FRAME. It's prepunched and tapped to screw in the Back Connectors.

ALDEN BACK CONNECTORS

PATENTED #462 - 1



#462-2

If you require slide-in guides, we furnish ALDEN SIDE RAIL, any length; also you can use ALDEN SERVE-A-UNIT LOCK which engages prepunched Back Frame to pull in and eject chassis.

137 N. Main St., Brockton 64, Mass.

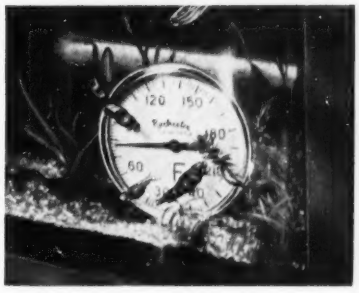
ALDEN PRODUCTS CO.

SEND FOR FREE SAMPLES — also request free "Alden Handbook" 226 pages of techniques and components for Unitized Plug-in Unit Construction.

For more information circle **113** on inquiry card.

Prevent thermometer fogging

No matter how long you dunk it, you can't cloud the accuracy of a Rochester dial thermometer.



THIS SUBMERSIBLE QUALITY is important to you. It means fast, easy temperature readings . . . without any danger of a foggy crystal causing inaccuracy. Rochester dial thermometers are assembled and hermetically sealed in a special humidity-controlled "dry" room. This eliminates any possibility of condensation inside the thermometer.

ALL STAINLESS STEEL CONSTRUCTION— All outer parts (except crystal) of Rochester dial thermometers are stainless steel. What's more, the case, stem and nut are fused into a single *corrosion-resistant* unit by an exclusive Rochester welding process.

EXCLUSIVE OUTSIDE RECALIBRATION— Rochester makes the *only* industrial thermometer that can be recalibrated from outside the case. If an extremely hard blow should knock it out of adjustment, you can have it back on the job in less than a minute . . . without taking the thermometer apart or breaking the hermetic seal.

You can order Rochester thermometers from one of our specialized instrument representatives listed in Sweet's Catalog. Or write direct for full details.

MILLIONS of Rochester dial thermometers are now delivering dependable service.

Rochester Manufacturing Company, Inc.
85 Rockwood St., Rochester 10, N. Y.

DIAL THERMOMETERS GAUGES AMMETERS

ROCHESTER GAUGES

For more information circle **114** on inquiry card.

LABORATORY APPROVED
Under MILITARY SPECIFICATION MIL-M-10304

- Will withstand Hi-Impact Shock Tests, extensive vibration and tumbling requirements, extreme thermal shock, humidity and temperature tests.
- Glass to metal type seal with molded vulcanized rubber terminal connections capable of carrying 30 amps for self-contained units.
- Magnetically shielded.
- Black satin onodized aluminum bezel.
- D'Arsonval permanent magnet type movement—for all D. C. Ranges.
- Available in 2½" and 3½" round case types.
- Guranteed one year against defective workmanship and materials.

BURLINGTON INSTRUMENTS ALSO AVAILABLE IN HERMETICALLY SEALED OR BAKELITE CASES IN 1½" THROUGH 4½" SIZES.

BURLINGTON INSTRUMENT COMPANY
DEPT. H-83, BURLINGTON, IOWA

For more information circle 115 on inquiry card.

For Eye-Level Readings...

AUTO-LITE

...TEMPERATURE INDICATION

Auto-Lite offers many thermometer styles, permitting plant-wide temperature observation at low cost. Standard temperature ranges from minus 60°F to plus 750°F. Send for latest catalog showing various types.

Model F-1 temperature indicator—Rigid stem or capillary tubing for EYE-LEVEL remote reading. Priced from $22.

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TEMPERATURE INDICATORS & RECORDERS

For more information circle 116 on inquiry card.

NEW INSTRUMENTS

glass seals for maximum voltage path in minimum space. Available in capacitances to 50 mmfds. and voltages to 15 kv.—*Dolinko & Wilkens, Inc.*, 1901-07 *Summit Ave., Union City, N. J.*

For more information circle 380 on inquiry card.

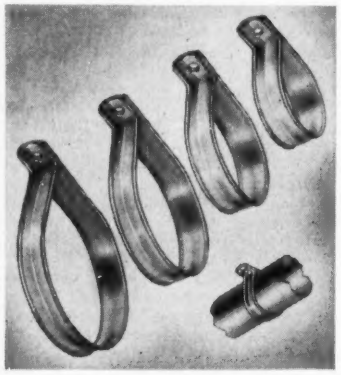
Miniature Capacitors

New "TWM Series" of high-temperature metal-cased miniaturized tubular capacitors, added to "Demicon" capacitor line, are of extended foil construction using new duPont Mylar polyester film dielectric. Through temperature range of —55 C. to 130 C., no voltage derating is required; to 160 C., derating only to 75 percent. Units are available in six variations of basic style, with selection of mounting brackets and threaded studs, in 100, 400 and 600 v.dc. ratings.—*Industrial Div., Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

For more information circle 381 on inquiry card.

Cable and Component Clip

New "7R EthoLoc" ethyl cellulose cable clip, available in sizes from 1½ in. to 3 in., is suitable for holding



batteries, capacitors, etc.—*Weckesser Co., 5261 N. Avondale Ave., Chicago 30, Ill.*

For more information circle 382 on inquiry card.

VALVES

Plastic Valves

New corrosion-resistant plastic globe and "Y" valves are constructed of Vanilene (polyethylene) except for sealing diaphragm on disk which is a polyethylene-polyisobutylene mixture to insure maximum resilience and drop tightness. Valves will withstand working pressures up to 50 psi. and temperatures to 150 F. At this time, ½-in., 1-in., 1½-in. and 2-in. sizes are available; larger sizes soon. —*Vanton Pump Corp., Empire State Bldg., New York City.*

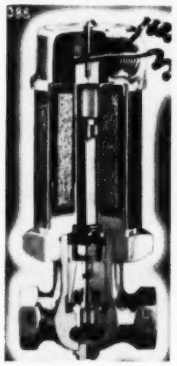
For more information circle 383 on inquiry card.

Pressure Relief Valves

Two new larger-size pressure relief valves are larger versions of original ¾-in. "No. 230" and are catalogued as "1-in. No. 230" and "1½-in. No. 230," for hot water boilers with heat

output to 743,400 Btu./hr. and 1,025,-100 Btu./hr., respectively; are designed to open at 30 psi.—*McDonnell & Miller, Inc., 3500 N. Spaulding Ave., Chicago 18, Ill.*

For more information circle **384** on inquiry card.

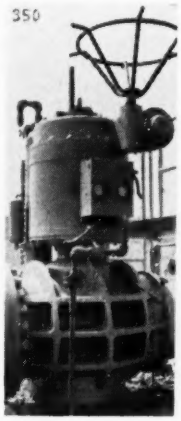


Steam Valve

New steam valve is said to offer new engineering principles which prevent sticking by automatically compensating for normal steam valve expansion and deposits.—*Dep't 138, Atkomatic Valve Co., 545 Abbott St., Indianapolis 25, Ind.*

For more information circle **385** on inquiry card.

Valve Operator



New "Plug Valve Operator," easily installed on existing 1½-in. to 30-in. plug valves, may be powered with gas, air, or liquid at pressures from 60 to 1000 psi.; is available for manual, cyclic, or automatic remote control—pneumatic, hydraulic or electric initiation. Unit illustrated opens or closes a 24-in. plug valve in two seconds without mechanical shock, is one of several at a gas compressor station all interlocked for quick closure when actuated from one of three emergency remote manual control stations, each being also actuated automatically in event of a main line break.—*Shafer Valve Co., Inc., P. O. Box 83, Mansfield, Ohio.*

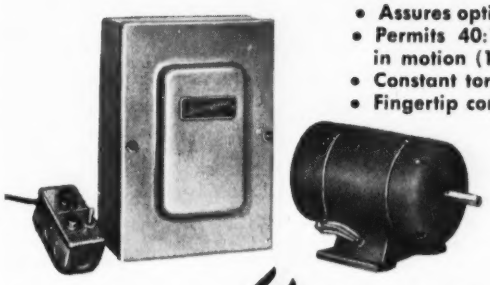
For more information circle **386** on inquiry card.

Needle Valves

New all-steel needle valves, for working pressures up to 10,000 psi., have bodies and stem guides machined from bar stock and joined into one-piece construction by "Conoweld" process instead of usual threaded connection, to provide leak-proof joint and eliminate danger of stem guide becoming loose while unscrewing stem. Packing is non-binding "Marpak."—*Marsh Instrument Co., Skokie, Illinois.*

For more information circle **387** on inquiry card.

VARIABLE SPEED CONTROL
STOCK DELIVERY



- Assures optimum process speed
- Permits 40:1 speed change while in motion (100 to 4000 rpm)
- Constant torque capability
- Fingertip control from remote point
- Electronic "SERVO" control
- ⅛ horsepower — 4000 rpm base speed — 115 volts and 230 volt models, 60 cycles

Uses: Coil winders, life test fixtures, proportioning pumps, printing presses, conveyers, small machine tools, etc.

MODEL 6301 FOR 230 VOLTS (WITH MOTOR) $149.50

MODEL 6701 FOR 115 VOLTS (WITH MOTOR) $159.50

OTHER MODELS AVAILABLE TO 3 HORSEPOWER

Servospeed DIV. of ELECTRO DEVICES, Inc.
4 Godwin Ave. Paterson, N. J.

For more information circle **117** on inquiry card.

BENDIX-FRIEZ

Just right for your job!

high-precision thermistors by **BENDIX-FRIEZ**

As temperature measuring elements and liquid level sensors, these temperature responsive resistors are the best you can buy. In standard or special types, their high-precision manufacture makes them precisely right for your job when it comes to resistance values, size, temperature coefficient, mountings and quality. Ask us about applications.

STANDARD TYPES FOR IMMEDIATE DELIVERY

Size (inches)	@ +30°C.	@ 0°C.	@ −30°C.
.140 x .75	45.0 ohms	86 ohms	194 ohms
.040 x 1.5	12,250 ohms	26,200 ohms	65,340 ohms
.018 x 1.5	35,000 ohms	82,290 ohms	229,600 ohms

Write for details.

Used in this typical application for sensing the temperature of hydraulic oil.

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For more information circle **118** on inquiry card.

The Secrets in an

INSTRUMENT ENGINEER'S NOTEBOOK

Too often, the many interesting and useful solutions to plant instrumentation problems that may be found in the Instrument Engineer's notebook lie unrevealed and lost.

By PORTER HART and R. C. KING
The Dow Chemical Co.

INSTRUMENT ENGINEERS' notebooks often contain solutions to measurement and control problems through use of standard instruments in unusual applications, or through use of shop-made devices not available commercially.

At times, the Instrument Shop is called on to design, build, or modify instruments for a particular job because standard instruments are not on hand. Occasionally, the Instrument Shop will be encouraged to build an inexpensive substitute for a commercial instrument. Usually, the makeshift instruments prove to be expensive, and are replaced by the proper equipment as soon as delivery can be made by the manufacturer.

Sometimes the Instrument Engineer discovers, to his chagrin, that the ingenious device he invented, developed, and built to solve a control problem was already on the market in some form; however, he may derive some consolation from the thought that he might never have heard of the commercial version if he hadn't proudly described his brain-child to so many people.

Proportional Sampling Device For Metered Liquids

Many plant product streams must be sampled for laboratory analysis as well as metered for accurate calculations of production. As both the analysis and flow rate vary, samples taken must have a direct relation to the product flow rate. The sampler shown in Fig. 1 was developed for such streams.

A flow integrator was installed in the flow meter. The integrator cam was made to operate a "Micro" switch for each increment of product flow. The "Micro" switch in turn energizes a three-way solenoid valve through which air supply is admitted to, or bled from, two diaphragm-motor-operated needle valves in the sample line. The control valve nearer the main product line is of the air-to-open type, and the second valve is of the air-to-close type. Between the two valves is a sealed sample trap arranged to drain when pressure on the line is released.

In operation, as each equal increment of product flows through the main line, the integrator cam trips the "Micro" switch. Air pressure is supplied to both control valves, opening the valve upstream from the sample trap and closing the valve downstream. A fixed quantity of sample is trapped between the two valves. When the integrator cam advances, it releases the "Micro" switch and de-energizes the three-way solenoid valve. The air from the diaphragm motors is bled off, causing the upstream valve to close and the downstream valve to open. The trapped sample drains to a sample container. At the end of each shift, or each day, the accumulated sample in the container is mixed and a laboratory sample taken from it. The container is then drained and is ready to accumulate the sample for the next period.

This sampling system has performed well in a number of installations over the past several years with a minimum of maintenance. The accuracy of the sampling system has proven to be within the accuracy of flow-meter measurements.

"Poidometer" For Control of Granular Material

There are numerous types of conveyor-weighers, such as the Schaffer "Poidometer," on the market. Each had some disadvantage which made it unsuitable for the control of wet oyster-shell feed to a kiln. Those with suitable sensitivity were not sufficiently rugged nor adequately protected from the corrosive conditions. Those that were rugged enough were not sufficiently sensitive.

The kiln feed belt was originally equipped with a mechanical scale, connecting the weight-sensitive roller through linkages directly to the feed gate. The feed-rate adjustment was by means of loading the scale beam with weights. This "Poidometer" was insensitive because it depended upon mechanical linkages and could not supply the power to adjust the feed gate adequately. It also had no means of recording the belt load so that it was impossible to calculate a material balance for the process.

A pneumatically operated "Poidometer," including a load recorder, was developed from components of standard instruments. The modified "Poidometer" is shown in Fig. 2. The linkage between the pivoted roller and the scale beam was replaced with an air-loaded balance, which is a standard control-valve diaphragm motor with the spring removed. The area of this diaphragm and the length of the lever arm were arranged so that—when in balance—each pound

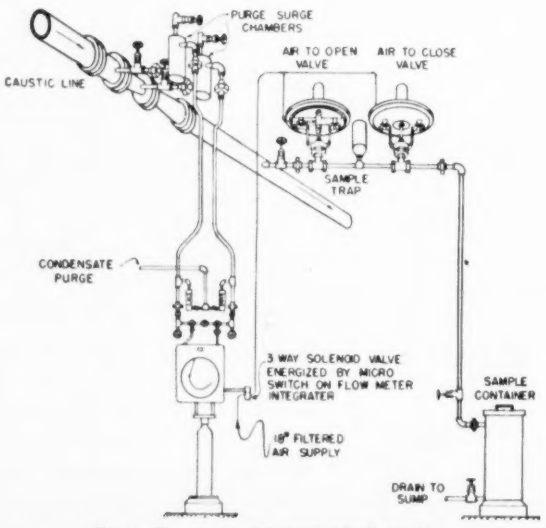

Fig. 1. Flow meter and proportional sampler.

Presented at the Eighth Annual Symposium on Instrumentation in the Process Industries, Texas A & M College, College Station, Texas, January 1953.

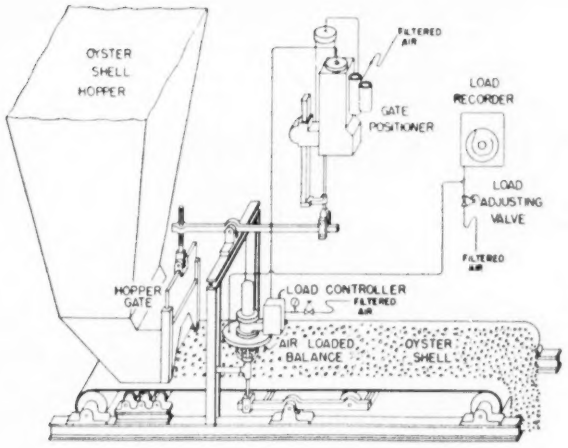

Fig. 2. "Poidometer" for shell feed control.

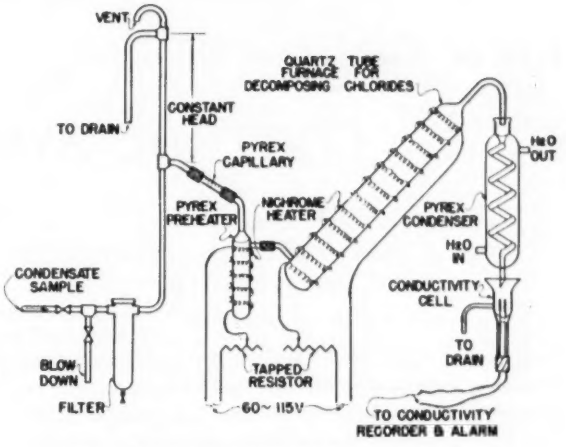

Fig. 4. Detector for organic chlorides in condensate.

of air pressure to the pneumatic balance equals a pound of load per foot on the feed belt.

A standard valve-positioner was used as a load controller to maintain the balance between the air loading and the load on the belt. The output of the positioner was connected externally to a piston-type pneumatic operator used to regulate the feed by adjusting the hopper gate. The output pressure was fed also to the control bellows of the positioner for stability.

This arrangement permits the recorder and the load-adjusting valve for the "Poidometer" to be located at the control end of the kiln. By using the "Poidometer" record and the footage counter on the feed belt, material balances can easily be calculated for production records.

This pneumatic "Poidometer" proved to be rugged and sensitive. Its action is positive and immediate, with no cycling. It has been in trouble-free operation for over five years.

Pressure Rate Alarms

In some reaction systems, a sudden change indicates a dangerous condition. As this change may occur over a range of operating conditions, a pressure alarm switch on the transmitter output cannot be used to give warning of the sudden change.

A pressure switch incorporating a rate-action feature to operate over the full range of the output of a standard pneumatic transmitter (Fig. 3) was built for this service. It was made from a standard bellows sub-assembly from a proportional-with-reset controller. A connection from the floating arm was made to actuate a "Micro" switch when the pressure in the upper bellows increased a definite amount over that of the lower bellows. A bleed in the form

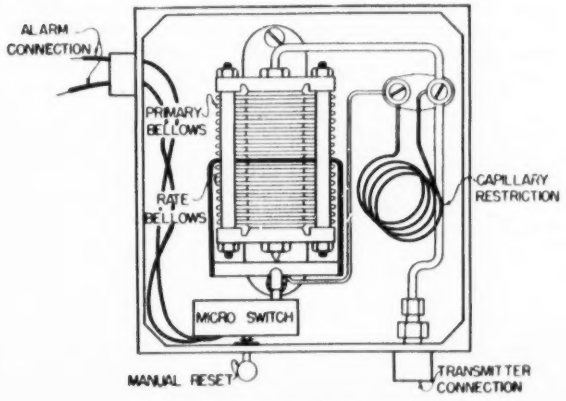

Fig. 3. Pressure rate alarm.

of a capillary restriction was installed between the two bellows. This bleed is adjusted to the operating conditions of the process.

The air pressure from the transmitter is connected directly to the upper bellows, and through the bleed restriction to the lower bellows. Thus, a gradual pressure change, such as is normally encountered, affects both bellows almost simultaneously, causing little movement of the floating arm. However, a sudden pressure increase from the transmitter forces the floating arm downward, closing the "Micro" switch and actuating the alarm. The "Micro" switch is of the manual-reset type so that the alarm is energized until a button is pushed to reset the alarm system. This gives the operator sufficient time to detect the source of trouble and correct it.

This system has operated satisfactorily on the type of installation described. The assembly is compact and is mounted in a standard cast-iron junction box.

Detector For Organic Chlorides In Condensate

The Power House in a chemical plant uses condensate returned from the various operating units as a large portion of its boiler feed water. A conductivity recorder to detect contamination in these condensate return lines is standard equipment. However, some of these contaminants are non-conductors and cannot be detected by the conductivity recorder. Chlorinated hydrocarbons, a type of contaminant which causes considerable damage to the boiler, are of this type.

A thermal cracker (Fig. 4) was constructed to decompose the organic chlorides and produce a conducting solution. A sample from the condensate return line is passed through a filter into a constant-head device so that a small but constant portion of the sample can be withdrawn with minimum time lag. A flash evaporator vaporizes the sample into the cracking unit. Any organic-chloride vapors are decomposed by contact with the hot quartz tube into hydrochloric acid and other products. The vapors from the cracking unit are condensed and the liquid formed allowed to flow over a conductivity cell.

Concentrations as low as a few parts per million may be detected easily. Unfortunately, hydrocarbons that do not contain any halogens in the molecule are not detected with this apparatus. This system has been in operation for a number of years and has proved its worth on several occasions.

Solution-Concentration Controller

Little has been done to automatically control continuous evaporators for concentrating solutions of chemicals. Normally, two primary conditions—pressure and temperature—affect the concentration of the final product.

A satisfactory control system was set up in which a pressure transmitter pneumatically set a temperature con-

Continued on page 1214

Use of Field Test Data for

CONTROL SYSTEM ANALYSIS

By P. R. HOYT AND B. D. STANTON
Shell Development Co.

Analysis of field test data on an operating fractionating column yields the performance and response characteristics necessary for complete system analysis. Test equipment, methods of producing step-input and frequency-type disturbances, and other practical factors are presented.

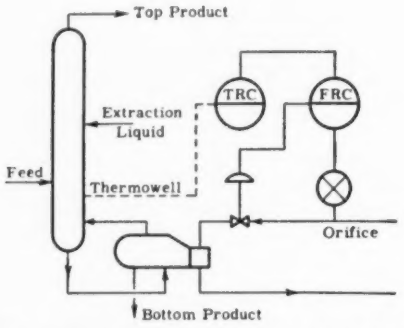

Fig. 1. Schematic diagram of process and control system.

PROCESS control engineers are becoming familiar with frequency-response methods for analyzing control systems. The method used is one of mathematical analysis supplemented by experimental data based on frequency-response tests. Dynamic characteristics of conventional controller actions and their relationships already have been determined and expressed in terms of frequency response[1, 2]. Information is available also on testing methods and equipment now being used for sine-wave and step-input disturbance tests[3]; recent developments of control system components with improved dynamic characteristics are evidence of the progress in this field.

The problems involved in testing processes are more complex. Two lines of approach are being followed: (1) Determination of the basic characteristics of various types of full-scale process equipment; here extensive tests can be planned and complete studies made over wide ranges of operating conditions because the only limitations are the test facilities; and (2) determination of the characteristics of complete and operating systems, including the process and the associated control-system elements. The data obtained under the latter conditions are comparatively limited because the tests must be made without causing serious plant upsets.

This article is concerned with the testing of a process under normal operating conditions; field tests of a temperature control system on an extractive distillation column are described. Test equipment, methods of introducing input disturbances and recording output responses, and some of the practical aspects of making the tests are discussed. Based on the test data, the response characteristics of the process and the control system components are determined, and the numerical values of their parameters are derived. It is shown that with this information alterations or rearrangement of components can be made which are both economical and practical, and the over-all control improvement can be predicted. The primary interest in the study was to determine if the speed of response and stability could be improved following a set-point change because savings can be realized by increasing the response rate and by restoring equilibrium in a minimum of time following changes of operating conditions.

System Tested

A schematic layout of the column and control system that was tested is shown in Fig. 1. This is a narrow-cut fractionating column with 65 trays. The feed, which is on flow control, enters the column on the 19th tray; the extraction solvent, also on flow control, is introduced on the 38th tray. Heat is supplied to the column through a kettle-type reboiler using hot oil as a heat medium. The flow of products and solvent leaving the bottom of the column is controlled by a level controller on the reboiler. The reflux is on flow control and the top product is controlled by a level controller on the tops accumulator. Pressure is controlled by bleeding gas into the tops accumulator. The column operates at atmospheric pressure or slightly above. As the desired product emerges from the bottom, the temperature-control sensing element is located in the lower part of the column. Experience had indicated the 4th tray as the optimum location, and on this tray the temperature must be held within plus or minus ½ deg. F.

The temperature control system (TRC) is of the cascade type (Fig. 2). The temperature-sensing element is a resistance thermometer, which is connected to an electronic temperature recorder with a span of 50-deg. F. A mechani-

Presented at the Eighth Annual Symposium on Instrumentation in the Process Industries, Texas A & M College, College Station, Texas, January 1953.

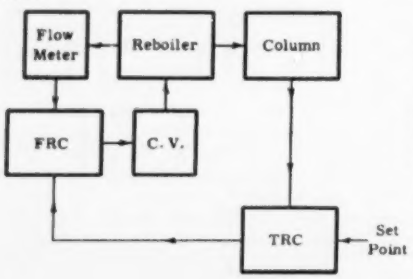

Fig. 2. Block diagram of the process control system. TRC is temperature recorder-controller; FRC is flow recorder-controller; CV is control valve.

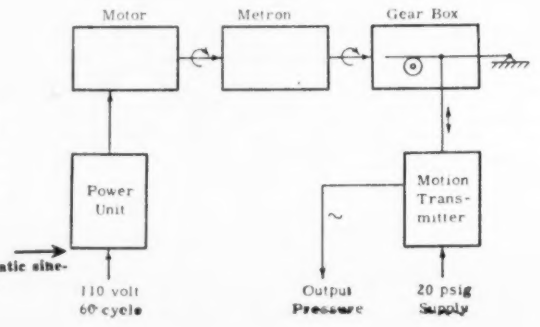

Fig. 3. Pneumatic sine-wave generator.

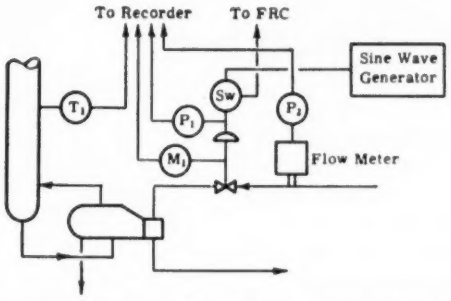

Fig. 4. Frequency-response test set-up.

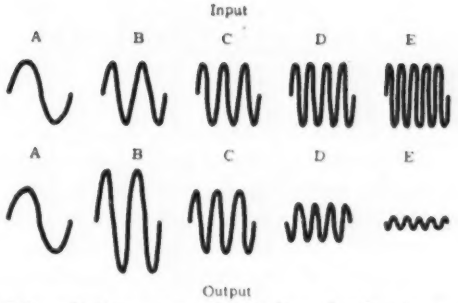

Fig. 6. Frequency-response data.

cal-pneumatic controller with proportional and reset functions is connected to the recorder. The pneumatic output signal from the controller adjusts the set point of a flow recorder controller (FRC), which controls the flow of heating medium to the reboiler. This FRC receives a pneumatic flow signal from a 0 to 100 inch mercury-manometer-type differential-pressure transmitter. Flow is converted to differential pressure by means of an orifice and flange-type pressure connections. The output of the FRC is connected to a valve positioner on the control valve. The control valve is a conventional diaphragm-spring-motor valve with a 6-inch body and an equal-percentage-type inner valve. The TRC and the FRC are located on the main panel board in the control room; the flow transmitter is locally mounted adjacent to the heat-medium control valve. The size and length of the transmission lines are as follows: 100 feet of ¼-inch-O.D. tubing from the flow transmitter to the recorder controller; 115 feet of ⅜-inch-O.D. tubing from the flow controller to the control valve; 10 feet of ⅜-inch tubing from the temperature controller to the set point of the flow recorder controller.

Test Equipment

The test equipment consisted of (1) sensing elements, (2) amplifiers and recorder, (3) a function generator, and (4) communication equipment. The complete system was electrical for high amplification, fast speed of response, flexibility, and ease of installation. The pick-ups were strain-gage-type pressure cells for measuring pressure, resistance thermometers for measuring temperature, and linear potentiometers for measuring motion. The recorder was a four-channel strip-chart-type, with chart speeds adjustable from ¼ to 100 mm./sec. Carrier-type amplifiers were used with the bridge-type measuring circuits and a d-c. amplifier with the linear potentiometer. The maximum measuring sensitivity was of the order of 50 mm. of pen travel for a temperature change of 1 deg. F., a pressure change of ¼ psig., or a linear motion of 3/16 inch. The function generator (Fig. 3) was designed to generate sine-wave pneumatic signals over the frequency and amplitude ranges required for most process-control systems. A variable-speed motor rotates an eccentric cam through an adjustable-speed-changer transmission unit. Through a lever system the cam operates a pneumatic motion transmitter, which in turn produces a pneumatic sine-wave output signal with less than 2 percent distortion up to 4 cps. In the tests to be described, frequencies from 1 cycle in 30 minutes to 1 cycle per second were used. The communication equipment consisted of four battery-powered telephone head sets connected in series.

Description of Tests

The field tests were confined primarily to obtaining the dynamic and static characteristics of the process. It was not necessary to make tests of the components in the control system because the characteristics of similar equipment already had been determined. However, some field measurements were made to determine the control function constants with the controllers in operation. Step-input and variable-frequency sine-wave-input disturbances were imparted to the system.

The test equipment was arranged as in Fig. 4. Both open-loop and closed-loop step-response tests were made first. Methods of analyzing open- and closed-loop transient-response curves are explained in the literature[4,5]. The open-loop transient response furnishes information on the static relationship (gain factors, linearity, etc.) and on the approximate dynamic characteristics (number and value of major time-constants, dead time, etc.) of elements in the control loop. Closed-loop response curves are useful as a means for observing and judging the performance of a complete control system (closed-loop linearity, speed of response, and damping ratio). By obtaining step-response data first, the information can be used as a guide in making subsequent frequency-response tests. By approximation methods[6] the time constants can be determined, to give an indication of the frequencies that would provide the most significant data.

The equipment (Fig. 4) was arranged to test the flow process and the temperature process simultaneously. The temperature process includes the heat-medium control valve, the reboiler, the column, and the thermowell with the resistance thermometer. The flow process includes the heat-medium control valve, the piping, and the mercury manometer. Air-pressure input to the control valve was measured at P_1 with a pressure pick-up, and the resulting valve-stem motion at M_1 with a linear potentiometer. Flow changes were measured at P_2 with a pressure pick-up connected to the output of the flow transmitter, and temperature changes at T_1 with a resistance element in a thermowell located on the control tray. The recording system and the sine-wave generator were located at ground level approximately 35 feet from the flow transmitter and control valve, which were

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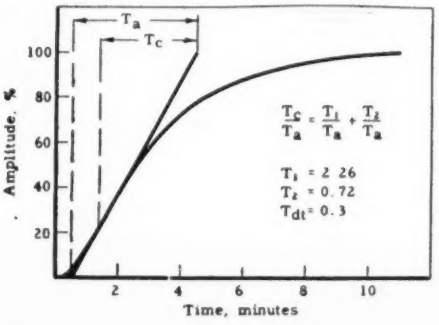

Fig. 5. Open-loop step-response across reboiler and column.

Amplitude Ratio (AR) = $\frac{A_{out}}{A_{in}}$

Decibels (db) = 20 $\log_{10}$ AR

Phase Shift (ϕ) = $\frac{360 \times t_1}{t_2}$

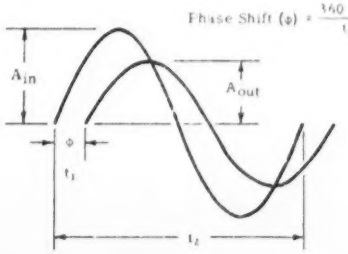

Fig. 7. Test-data interpretation.

Control of Chemical Processes

The eighth installment in this series on process control covers the reasons for the popularity of pneumatic controllers, and the basic pneumatic techniques for obtaining narrow-band (or on/off) control action, wide-band proportional-control action, and derivative and integral control actions. Included also are valve characteristics, valve positioners, and the importance of the interaction between derivative and integral actions.

by
A. J. YOUNG

VIII. Pneumatic-control Technique

Most controllers now in use in chemical and other process industries are operated pneumatically. However, the "all-electric" or "all-electronic" controller is becoming a successful rival.

The reasons for the popularity of air-operated equipment are discussed briefly. It will be seen that modern electrical and electronic technique can provide a good answer to each of these reasons except one—there is no electrical rival to the air-operated diaphragm control valve. However, an electrically operated valve based on a completely new design does seem at last to be a probability rather than a desirable possibility.

Reasons for Popularity of Pneumatic Controllers

Flameproof Requirements

The cradle of automatic control was the American oil industry, and one of the first requirements of equipment developed for the oil industry was safety against fire and explosion hazards in the refinery. It was natural, therefore, that pneumatic, hydraulic, or mechanically operated instruments should be developed by instrument manufacturers who were anxious to supply the demand. Once the initial impetus was given along these lines, installation of pneumatic equipment became orthodox practice. Perhaps the manufacturers of electric and electronic equipment would have had more success if they had realized how many plant control problems can be solved by using narrow-band proportional control without integral-control action. However, today the "all-electric" controllers offer advantages in performances and can satisfy flameproofing requirements.

Ease of Generation of Control Actions

Although proportional action is easily obtained electrically, it has been more difficult to generate integral action with the long time-constants (of the order of minutes up to half an hour), which are required for process work. Pneumatic operation, however, has provided a simple and economical means of generating integral action.

Derivative action, which was introduced much more recently, is again a simple matter to produce by pneumatic arrangements. It was, therefore, added to existing proportional plus integral controllers without difficulty.

Advances in application technique, and requirements for more and more precision in control, have made increasing demands for stability of calibration of the integral and derivative units. The best equipment has been able to keep pace with the demand by careful attention to the design and manufacture of the "restrictors"; however, the provision of precision and stability should be easier to provide in electrical equipment, now that improvements in electrical components (particularly capacitors) and techniques have made the design of all-electrical controllers (with proportional plus integral plus derivative control actions) a practical possibility. In America and in Europe, "all-electronic" three-action controllers are now operating successfully.

Simplicity and Low Maintenance

Air-operated controllers are simple in construction and are cheap to maintain, given reasonable operating conditions. There is little to go wrong provided the controller is made well and supplied with clean air during its working life. The risk of interference by dirt and attack by corrosive atmospheres is automatically minimized by the constant air bleed from the controller itself, which is thus purged continuously with clean air.

The amount of air used by a controller varies from one proprietary instrument to another, but is usually between 0.2 and 0.5 cu. ft. per min. In a large plant where large air compressors are required for other services, the cost of such air per controller might be as low as $10 per annum.

Control Valve

The reliability and low maintenance cost of the air-operated diaphragm valve, coupled with its comparatively low initial cost, make it an obvious choice until a completely-new electrically-operated valve which is made competitive on all counts is developed. The simplicity and efficiency of the diaphragm valve has done much to popularize not only pneumatic controllers but automatic control itself.

The Future Trend

For many years to come, the pneumatic controller will retain its popularity. However, only those makers will hold their ground who meet the requirements made necessary by the increasing need for precision control. This need demands calibrated setting dials for the integral and derivation action times, and stable retention of the calibration over long periods in use.

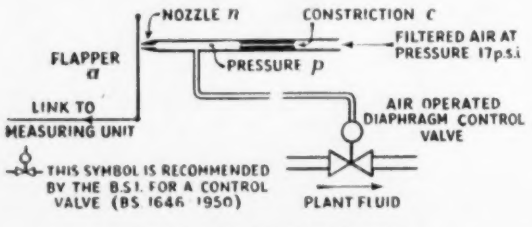
NOZZLE n
CONSTRICTION c
FILTERED AIR AT PRESSURE 17p.s.i
FLAPPER a
PRESSURE p
LINK TO MEASURING UNIT
AIR OPERATED DIAPHRAGM CONTROL VALVE
THIS SYMBOL IS RECOMMENDED BY THE B.S.I. FOR A CONTROL VALVE (BS 1646 1950)
PLANT FLUID

Fig. 8-1. Basic flapper/nozzle system.

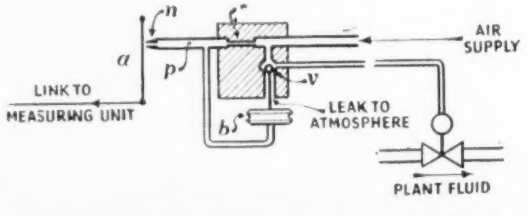

Fig. 8-2. Flapper/nozzle system with relay valve (continuous-bleed direct-action type).

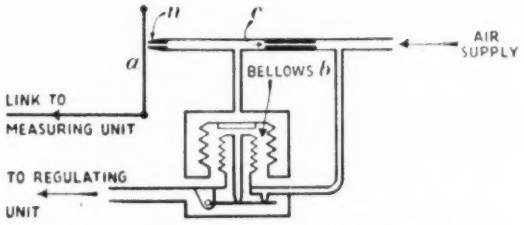

Fig. 8-3. Flapper/nozzle system with relay valve (non-bleed reverse-action type).

Generating Control Actions in Pneumatic Controllers

Many engineers and managers of chemical plant must often wonder why controllers vary widely in cost, or why there is a basic difference between a wide-band proportional controller and a narrow-band controller. The basic design principles provide the answer to these questions.

Two-position Control Action

The basic principle employed in most controllers, whatever action they generate, is shown in Fig. 8-1. Filtered air is fed into the system at constant pressure. It flows through constriction C to nozzle N, from which it escapes to atmosphere at a rate depending on the position of plate A. This plate is called the "flapper," "baffle," or "vane."

The constriction C is smaller than the constriction in the nozzle and hence gives a greater pressure drop than the nozzle. Suppose C gives a four times greater pressure drop than does N. Then, if the flapper A is too far from N to affect the flow, and the constant-pressure air supply is at 20 psi., the pressure p will be 4 psi.

If A is now moved up to N so that it completely closes the nozzle, pressure p rises to 20 psi. If A is now moved slowly away from N, the pressure p drops again to 4 psi. after a small movement of A. This movement has generally been considered to be of the order of 0.002 inch; recent measurements made on a widely used controller showed that the movement was ¼ of 0.001 in.

This system can change pressure p from 4 to 20 psi. when the position of A relative to N is changed by as little as 0.002 in. Therefore, by pivoting A at a fixed point F and linking it to a measuring unit, a sensitive two-position (or on/off) control action is obtained.

Need For a Relay Valve

The performance of this simple system is limited severely by the slow rate at which pressure p changes when A moves to a new position—if the regulating unit (and the line to it) has considerable capacity. Table 1 shows the time lag for this system used with a typical control valve. The rate of increase of p is limited by the rate at which the supply air flows through the constriction C; the rate of decrease is limited by the rate of air leakage to atmosphere through N.

The diameter of N must be made small so that the force exerted on A by the jet of air from N is negligibly small compared to the working force available to deflect the measuring-unit pointer or pen arm. This is particularly important when the measuring unit is a deflectional one, such as a milliammeter or a gas-filled thermometer. When it is servo operated (e.g., a self-balancing potentiometer) the working force available to position the flapper is larger and the "jet pressure" permissible is correspondingly greater.

Table 1.—Time Lag in Seconds Due To Capacitance and Resistance of Connecting Tubing and Regulating Unit.

Diaphragm diameter, (in.)	*Length of 3/8-in.-O.D. copper tubing connecting controller to regulating unit*		
	1 ft.	500 ft.	500 ft. with positioner.*
16	1.4 sec.	8 sec.	3 sec.
12	1 sec.	4 sec.	2 sec.

*The effect of the positioner on lags with short connecting tubing is negligible; the positioner may still be required for accurate positioning of the regulating unit.

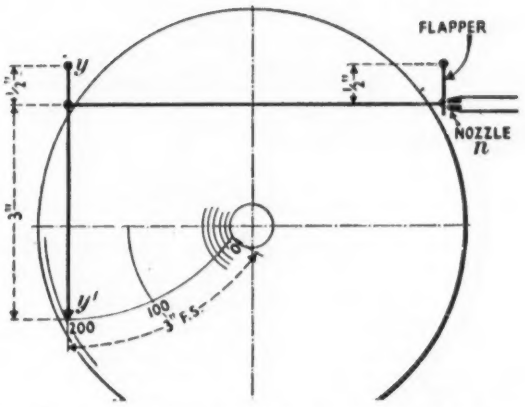

Fig. 8-4. Diagram of narrow-band proportional-controller linkage.

Most makers, however, make one standard control unit to operate from all types of measuring unit, and the nozzle is therefore made as fine as practicable. The lower limit of nozzle and constriction diameters is set by the necessity of avoiding "blocking up" by the fine particles of dust, oil, or water which are not removed by the filters normally used. Precautions are necessary to obtain completely dry air, free of all oil and dust. In general, therefore, the nozzle diameter is of order 0.04 to 0.02 in.; that of C is two or three times smaller.

The small nozzle diameter ensures low jet-pressure on A, and hence negligible reaction on the measuring unit, and also reduces waste of air. On the other hand, it necessitates the use of a relay valve (Fig. 8-2) to provide rapid response.

Operation of Relay Valve

As seen from Fig. 8-2, if p decreases to minimum value, the bellows B contracts and moves valve V, so that air at supply pressure is transmitted to the regulating unit. If p increases to maximum value, valve V cuts off the supply air and allows the air under pressure in the regulating unit and connecting pipe to escape rapidly to atmosphere.

As the output pressure decreases as p increases and vice versa, this relay valve is said to be "reverse acting." A "direct-acting" valve is shown in Fig. 8-3. Either valve can easily be modified to obtain the opposite action.

There is a basic difference between the two relay-valve designs, which is of importance when they are used with proportional controllers—the valve in Fig. 8-2 bleeds air to atmosphere from supply whenever it is not at one or other end of its travel; that in Fig. 8-3 does not waste air in this way and is called a "non-bleed" type.

Amplification, a Second Function of the Relay Valve

In addition to increasing the response speed of the system, the relay valve often is made to amplify the change in p. For example, in Fig. 8-2, bellows B can be made so that it moves valve V over its complete travel for a change of, say, 4 psi. Hence, if p changes from 4 psi. (its minimum value in the example chosen) to 8 psi., the controller output will change from 20 to 0 psi.

This means that the maximum jet pressure on flapper A is reduced, and also the change in jet pressure exerted throughout the range of movement of A is reduced. It also means that flapper A need not seal the nozzle in order to give maximum controller output pressure. Several controllers employ this property of the relay valve so that the working range of p is low, say, 6 or 8 psi.

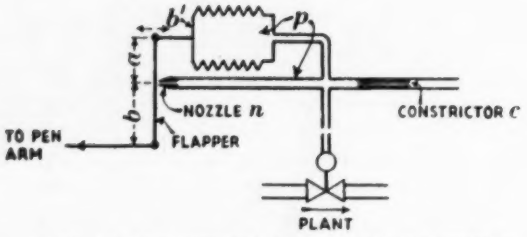

Fig. 8-5. Basic "feed-back" system of wide-band controller.

Narrow-band Proportional Action

When flapper A is moved away from nozzle N, the pressure p is proportional to the distance of A from N. Therefore, proportional action can be obtained from the system of Fig. 8-1.

Each value of the controlled condition (e.g., temperature) measured by the measuring unit corresponds to a unique position of the flapper A relative to the nozzle, and hence to a unique pressure p on the regulating unit. (It has been stated previously that this correspondence of each value of the flapper position to a definite controller output-pressure and regulating-unit setting explains offset due to load change.)

Note that the proportional action is obtained over a small movement of the flapper (say, 0.002 in.). Let us see what this high sensitivity leads to in a practical instance. In Fig. 8-4, YY′ is the pen arm of a circular-chart temperature recorder/controller with range 0 to 200 deg C. and chart width of 3 in. If the dimensions of pen arm and flapper are as shown, a movement of 0.002 in. of the flapper will correspond to a pen movement of 0.47 percent of full scale, or 0.94 deg. C. Thus the proportional band-width of this recorder/controller is less than ½ percent, which is equivalent for practical purposes to two-position control.

In order to obtain a band-width of only 10 percent, the ratio of flapper movement to pen movement must be made 20 times smaller, giving an overall reduction ratio of 140. Such reductions can be constructed. Reductions of higher order, however, demand uneconomic precision in manufacture. Proportional band-width wider than about 10 percent is, therefore, usually obtained by a pneumatic feedback system, which presents an economic method of reducing the effective flapper movement per unit pen movement.

Wide-band Proportional Action

In Fig. 8-5, the simple system of Fig. 8-1 has been modified to give a wide proportional band. Bellows b' is connected pneumatically at its fixed end as shown; it is thus maintained at pressure p. The free end of the bellows carries an extension to which the flapper is pivoted.

If the pen arm moves to the right, p increases and b' expands. The upper end of the flapper is moved to the left. Hence the movement of the flapper opposite the nozzle is reduced; the desired decrease in "sensitivity" is thus provided. The extent of the decrease depends on (Fig. 8-5) the ratio of $a : b$ and the extension of bellows b' per unit change in p. Variation of either of these factors causes a change in the proportional band-width. In practice, the ratio $a : b$ is usually selected as the means of altering the band-width, as will be seen from the designs.

This "pneumatic feedback" system is simple and yet enables the flapper to be positioned with a precision of the order of millionths of an inch.

Setting "Desired Value"

When the desired-value pointer and the pen arm are aligned together, the output of the controller in steady conditions should be 9 psi. (midpoint of the range 3 to 15 psi.). There is only one separation of flapper and nozzle which gives this output pressure. Hence the function of the "desired-value" setting arrangement is to provide that this separation exists when the controlled condition is at the desired value—i.e., when pointer and pen arm are aligned.

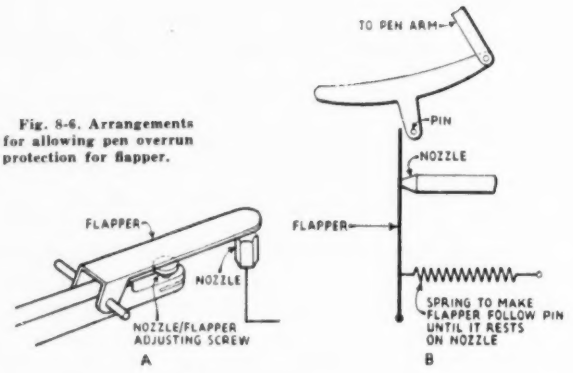

Fig. 8-6. Arrangements for allowing pen overrun protection for flapper.

As both desired value and proportional band-width settings may be changed during operation, it is necessary to ensure that adjustment of one does not change adjustment of the other. This condition implies that change of band-width does not change flapper-nozzle separation at the mid-point of the band, and that change of desired value does not alter the ratio $a : b$.

The methods by which this is achieved are indicated for several types of controllers.

Provision for Free Motion of Pen Arm

In Figs. 8-1 to 8-5, the pen is shown linked to the baffle. In practice, provision must be made for the pen arm to move freely beyond the point at which it has brought the flapper up to the nozzle face. Two devices for doing this are shown in Fig. 8-6.

Note that a restraining force keeps the flapper in contact with the arm pushing it. This force must either be small compared to the working force available to move the pen arm, or uniform throughout the range.

Range of Proportional Band-width

With pneumatic feedback systems, proportional bands from 0 to 600 percent are available. Band-widths greater than 300 percent are seldom required.

It is advantageous to use the narrowest band-width compatible with stability of control. Offset cannot be greater than half the band-width, unless the regulating unit is inadequate, because the controller is giving either its minimum or maximum output at this value.

Valve Characteristics and Proportional Control

The proportional controller gives an output pressure proportional to deviation from desired value, but proportional control will only be achieved if the regulating unit translates this proportional pressure into a proportional change of controlled variable. For example, a proportional controller operating an electric regulating unit to control temperature in an oven would not give truly proportional control if the regulator gave a linear relation between temperature deviation and electric current change—because the heating effect is proportional to the square of the current.

When controlling flow, it is generally an advantage to use a valve which gives equal-percentage changes in flow for equal changes in valve position through a wide range of valve movement. On the other hand, if large changes in demand are anticipated, it may be useful to employ a valve which gives increasing percentages of flow change for unit movement, on either side of the normal operating range.

It is always necessary to ensure that the pressure drop across the valve (compared to other pressure drops in the line) is the major factor in determining the flow rate. In general, the valve size must be less than the line size.

Any regulating unit must be chosen to give the safe position if air supply fails. It must close or open on air failure according to the plant requirements.

Consideration must be given to the use of a *valve positioner* to overcome "sticking" of the valve if the best control is required.

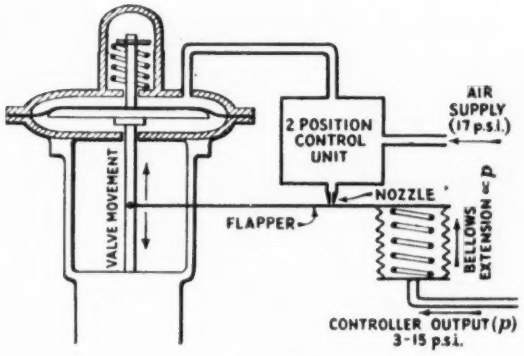

Fig. 8-7. Principle of valve positioner.

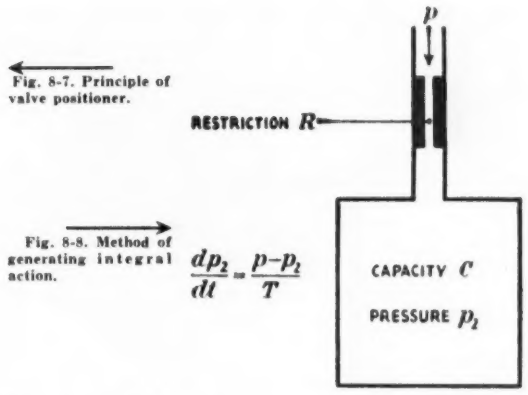

Fig. 8-8. Method of generating integral action.

Valve Positioner

The valve positioner (Fig. 8-7) is designed to apply the full air-supply pressure to the diaphragm until the valve position is accurately adjusted to that called for by the controller. It can be thought of as a two-position (or narrow-band-proportional) control unit, operating from a "measuring unit." The latter measures the difference between the actual valve position and that called for by the controller (as measured by the pressure output of the controller). The function of the control unit is to reduce this difference to zero. The result is that large forces are available to overcome any "sticking," particularly when small movements are required. A second purpose of the positioner is to make the valve movements more rapid (Table 1).

Generating Proportional plus Integral Action

It has been shown that proportional control action alone gives a definite setting of the regulating unit for each value of the deviation within the control band, and that it is therefore impossible, by using proportional action alone, to restore the deviation to zero if any permanent change of either supply or demand occurs.

If a narrow proportional band is used, the offset due to any likely supply or demand changes may be small enough to be permissible without harm to the process. For example, if a 10 percent proportional band is used on a recorder/controller of range 100 deg C., the maximum offset possible (whatever the change in supply or demand) is ± 5 deg. C.* because at this value the controller output will be either 3 or 15 psi. and the regulating unit will be either full open or shut. In practice, the normal supply or demand changes in the system might not be large enough to give more than ± 1 C. degree.

However, if the proportional band had to be increased from 10 to 50 percent, the offset would become ± 5 deg. C., and perhaps too great for satisfactory plant operation. In such circumstances integral action should be employed.

Integral action is designed to produce a correction which increases at a *rate* proportional to the deviation. In order to generate an action which increases at a rate proportional to θ, it is natural to use a system containing a capacity fed through a resistance. Fig. 8-8 shows a vessel of capacitance (or volume) C being fed with air at pressure p through a constriction having resistance R to air flow.

The *rate* at which p_2 changes depends directly on the pressure difference $p - p_2$ and inversely as the product of the resistance R and capacitance C.

$$dp_2/dt = (p - p_2)/CR = \triangle p/T \qquad (1)$$

If a proportional controller is operating steadily at desired value, the pressures on both sides of the restriction in Fig. 8-8 will be the same (p_2). Immediately following a sudden deviation (θ) in controlled condition, the output pressure (p) will change. The difference $p - p_2$, or $\triangle p$, will be proportional to θ. Therefore

$$dp_2/dt = \triangle p/T \propto \theta/T \qquad (2)$$

This, by definition, is integral action because the *rate* of controller action is proportional to the deviation, and hence the potential correction equals the integral of θdt. That is, $\Theta = (1/T) \int \theta\, dt$. Fig. 8-9 shows a controller mechanism for producing integral action (in addition to proportional and derivative actions). The capacity is a bellows which adds a component proportional to p_2 to the "sensitivity reduction" brought about by the "feed-back" bellows.

The integral contribution continues until θ is reduced to zero and is always proportional to p_2. Since p_2 is proportional to the integral of θdt, integral action builds up until $\theta = 0$, and its effect is inversely proportional to T, the time constant of the system.

Integral-action Time

The amount of integral action employed in a proportional plus integral action controller is defined in terms of a time S, which is proportional to T. It is called the integral-action time and it is used instead of T because it is easy to determine directly in terms of the proportional action.

By definition, the integral-action time is the time (S) taken for the integral action to increase by an amount equal to the proportional action *when the deviation θ is held constant.*

Since the potential correction due to proportional action is $\Theta_p = -\mu\theta$, the definition means that the integral action must be generated at such a rate that

$$\Theta_p = -\mu\theta = -\gamma \int^t \theta\, dt$$
$$= -\gamma\, \theta\, S \text{ (since } \theta \text{ is assumed constant for a time } t \text{ equal to } S).$$

Therefore $\gamma = \mu/S$

The contribution of integral action increases as S decreases. It has already been stated that usually the optimum value of S is that equal to the natural period of the plant. (See equation 6 of chapter 7 for the complete controller equation.)

Generating Proportional Plus Derivative Action

Derivative action must add a component to controller output which is proportional to the *rate* of change of deviation.

The resistance of a restrictor to air flow is again employed. The action is produced by decreasing the sensitivity reduction due to the "feed-back" system; i.e., the sensitivity of the flapper/nozzle system is increased.

The output pressure p of the controller (Fig. 8-9) is applied to the feed-back bellows through the "derivative restrictor." A sudden change in p due to a change in deviation θ will therefore not be transmitted immediately to the bellows. Consequently the bellows will be delayed in counteracting the flapper movement produced by the measuring unit. Hence the sensitivity of the system will be increased while θ is changing. The faster the change in θ, the greater the effect. The effect is proportional to the *rate* of change of θ.

The contribution of the derivative action depends on the restrictor resistance and the "feed-back" bellows capacity.

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*Provided that the regulating unit is half open at the desired value, and that it is of sufficient capacity to deal with the largest changes in conditions which are encountered.

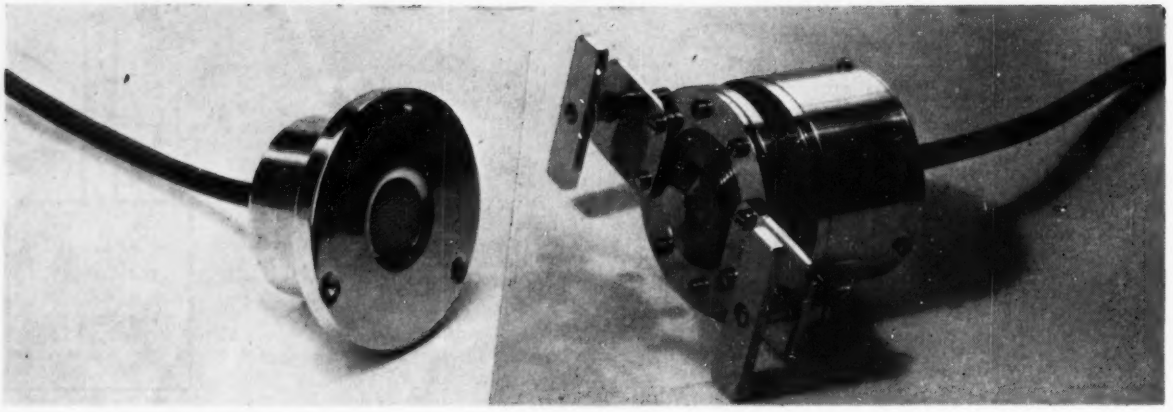

Fig. 1. (Left), typical baffle-type electrokinetic transducer; (right), electrokinetic transducer used for measuring small displacements.

Electrokinetic Transducers

Electrokinetic cells use the streaming potential developed when a polar liquid is forced through a porous plug. The principle, properties, and applications are discussed, including sensitivity, impedance, frequency response, pressure range, linearity, noise, acceleration sensitivity, mechanical impedance, temperature range, and impedance matching. Differences between electrokinetic cells and other pressure-sensitive transducers are emphasized.

By E. V. HARDWAY, JR.
The Beta Corporation

PIEZOELECTRIC, electromagnetic, and magnetostrictive energy-conversion devices are familiar transducers for measurement of time-varying mechanical quantities. Strain gages, differential transformers, and variable-resistance devices also are familiar transducers, although they require an external source of electrical energy. A fundamentally new type of transducer*, which is finding increasing use in instrumentation, is entirely different from these other transducers in principle of operation, and in its advantages and limitations in various applications. It employs the electrokinetic phenomenon known as "streaming potential," which occurs when a polar liquid is forced through a capillary or porous plug.

The streaming potential phenomenon was discovered by Quincke[1] in 1859, the theory of its origin having been developed by Helmholtz[2], Smoluchowski[3], and others since that date. Interest in this phenomenon has, however, been limited largely to research in the fields of biochemistry, physical chemistry, and electrochemistry. Only in the past few years have the advantages of electrokinetic cells as transducing elements in certain types of instruments been recognized. Williams[4, 5] developed the first experimental electrokinetic transducers for use in measuring hammer in oil lines.

Recent work conducted by The Beta Corporation has been concerned with (1) selection of materials for maximizing efficiency, (2) obtaining low or negligible temperature-coefficients, (3) securing long-term stability, (4) developing a more complete theory of transducer operation satisfying energy requirements for a passive system, and (5) designing a number of different types of instruments employing electrokinetic cells*.

*Patent 2,615,940. Other patents pending.

Streaming Potential

Fig. 2 is a cut-away section of a round glass tube into which a plug of a porous material (such as porcelain or fritted glass) has been fused. Wire screen electrodes are located on each side of the porous plug and are attached to external leads. The tube is filled with a polar liquid (such as methanol, water, or acetonitrile), which flows under the applied pressure P at a volume velocity V. H refers to the potential across the plug or electrodes (neglecting polarization), and I is the current flowing in an external circuit.

*Research on electrokinetic cells has been supported in part by the Office of Naval Research.

At the interface between the polar liquid and the solid porous plug, the molecules of liquid are adsorbed with a preferred orientation, and ions are preferentially adsorbed by the solid—causing a charged double layer to develop at the interface. The interface is analogous to a capacitor with plates separated by a few molecular spacings. Although the ion distribution in this layer is diffuse, the inner movable layer in a given pore of the plug may be considered to be a fixed distance from the pore wall at an electrostatic "center of gravity." The charge per unit area of the inner layer multiplied by the double layer thickness is defined as the *electric moment* of the double layer, or β.

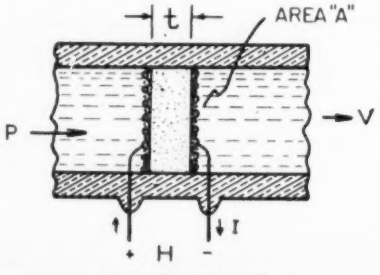

Fig. 2. Streaming cell.

When the liquid is forced through the pores of the plug the charged layer on the pore walls remains stationary, whereas the inner diffuse layer moves with the liquid, causing charged ions to be transported with the liquid. When the electrodes are not connected to an external load, an equal reverse current will flow through the center portion of the pores due to the liquid's bulk conductivity. A streaming potential is developed as a result of this flow, which potential is proportional to the applied pressure. The potential is independent of the area and length of the plug and, except for very fine material, the size of the pores.

This phenomenon is reversible—that is, if a voltage H is applied, the applied voltage either causes liquid to flow with no external pressure difference, or else produces an electro-osmotic pressure when flow is prevented. (This reverse phenomenon, known as electro-osmosis, was discovered by Reuss in 1808, fifty-one years prior to the discovery of streaming potential by Quincke.)

Two equations relate the various electrokinetic phenomena occurring in a porous plug:

$$P = -MH + V\,[t/(k_V A)]$$
$$I = MV + H\,[(K_0 A)/t]$$

Neglecting potential drops due to electrode polarization, these equations describe the action of a liquid-filled porous plug as a transducer converting energy in either direction. In these equations M is the transducer electromechanical coupling constant, k_V is the average flow conductivity of the plug material to the particular liquid, and K_0 is the effective electrical conductivity of the liquid-filled porous solid. A and t are the area and thickness of the plug.

The electromechanical coupling constant M relates the osmotic pressure to an applied potential when no flow is permitted:

$$M = -(P/H)_{V=0}$$

It can be shown also that the electromechanical coupling constant is proportional to the electric moment of the double layer (β), which is unique to the solid-liquid combination, a porosity factor F, and inversely to a permeability factor B. Both of the latter are unique to the porous solid material:

$$M = \beta F/B$$

The electrical conductivity K_0 depends on the liquid's conductivity, the porosity F, and other factors. It may be experimentally determined simply by measuring the a-c. resistance of the plug (R_0) and using the relation:

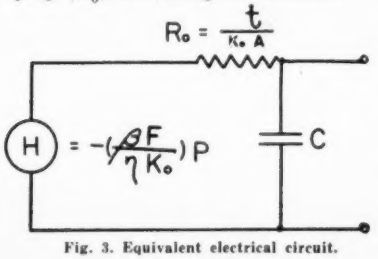

Fig. 3. Equivalent electrical circuit.

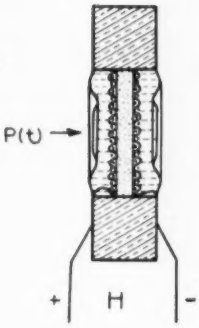

Fig. 4. An electrokinetic cell.

$$K_0 = (1/R_0)\,(t/A)$$

The flow conductivity k_V is related to the viscosity of the liquid η and the permeability characteristic of the solid B by:

$$k_V = B/\eta$$

In instances where a pressure is applied and the open-circuit sensitivity is measured, the osmotic pressure is negligible and the voltage-pressure sensitivity is given by:

$$(H/P)_{I=0} = -Mk_V/K_0 = -\beta F/\eta K_0$$

For *large* pores, where the conductivity is dependent largely on the conductivity of the liquid K_L, the expression may be written as:

$$(H/P)_{I=0} \cong -\beta/\eta K_L$$

In certain combinations of materials both the electric moment β and the viscosity-conductivity product ηK_0 are substantially independent of temperature over a wide range, causing the voltage sensitivity to be independent of temperature.

An equivalent electrical circuit for the device (suitable where the load is passive), is given in Fig. 3. Capacitor C simply represents the internal capacity of the plug, its effects being negligible except at ultrasonic frequencies.

The Electrokinetic Cell

Only a limited quantity of liquid can be incorporated in a measuring instrument. To continuously measure a pressure with the device shown in Fig. 2, an unlimited supply of liquid would be required on the upstream side. It becomes impractical, therefore, to attempt to devise an electrokinetic transducer suitable for measuring steady values for prolonged periods. (A single exception is in the measurement of angular acceleration.)

An electrokinetic cell is here defined as an electrokinetic transducing element enclosing a *fixed* body of liquid, as in Fig. 4. The plug or disk is glazed into a dense impermeable ring with flat faces, both ends being enclosed by thin, flexible metal diaphragms. Sealing pressures are maintained by clamp rings and gaskets (not shown). The wire mesh electrodes are connected to the metal diaphragms and to the external circuit.

A pressure $P(t)$ applied to one diaphragm will cause liquid in one chamber to flow through the plug to the other chamber, and cause a voltage H to develop proportional to $P(t)$ less the opposing pressure due to the stiffness of the diaphragms. The latter is negligible compared to the applied pressure in the useful range of operation. The stiffness of the diaphragms and the flow resistance of the plug determine the low-frequency limit of the cell. In practice this limit has been extended as low as 0.02 cps., and can be extended indefinitely downward by design, but can never reach zero.

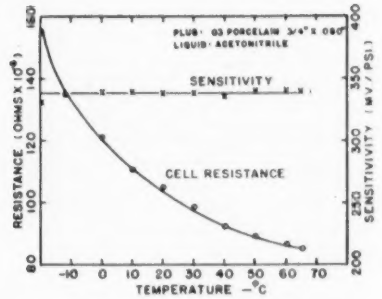

Fig. 5. Curves of sensitivity and resistance vs. temperature for a typical transducer.

If k_d is the effective pressure stiffness of the diaphragms (pressure per unit average displacement), the low-frequency limit f_L at which the sensitivity of the cell decreases to $1/\sqrt{2}$ of its mid-band value is:

$$f_L = Bk_d/2\pi\eta t$$

It is evident that this limit can be lowered by using (1) a finer (less permeable) material, (2) larger or more flexible diaphragms, (3) a thicker plug, or (4) a more viscous liquid. The most effective method is to increase the ratio of the diaphragm diameter to plug diameter. (This is not directly indicated in the relation above, which is based on Fig. 3.)

Accurate response to pulses of pressure is obtained when the pulse duration is short relative to the low-frequency response-limit of the cell. If the exponential decay in response due to diaphragm stiffness is to be less than 5 percent of the maximum signal amplitude, the allowable pulse duration T is:

$$T \leq 1/126f_L$$

The maximum *static* differential-pressure which may be withstood by the cell depends on the strength (and hence the thickness) of the diaphragms. Therefore, transducers designed for operation at higher static pressures have poorer low-frequency response unless means are provided for equalization. Such means in relatively simple forms are required, for example, in hydrophones for underwater measurements at high hydrostatic pressures.

Application Factors

When considering the use of electrokinetic cells for a given application a number of factors must be taken into consideration.

Sensitivity and Impedance

A typical plot of sensitivity and resistance versus temperature for a small transducer employing a ¾-in. O.D. x 0.080-in. ultra-fine porous porcelain disk is given in Fig. 5. Sensitivities from 250 to 500 mv./psi. or higher may be obtained with acetonitrile and porcelain. For this combination the sensitivity is substantially independent of temperature. When the load impedance is comparable to the cell impedance, the effect of temperature on sensitivity must be compensated by means of an NTC (negative-temperature-coefficient) resistor in the external circuit. For high-impedance loads no compensation for temperature is necessary. Cell impedances as low as 20,000 ohms, for example, may be obtained using porous disks with diameter of 2 inches.

Frequency Response

Factors affecting low-frequency response have been discussed. For very low frequencies (below about 1 cps.), polarization effects become important for loads comparable to the cell resistance. In applications requiring optimum response at very low frequencies, electrokinetic transducers should be used with high-impedance loads.

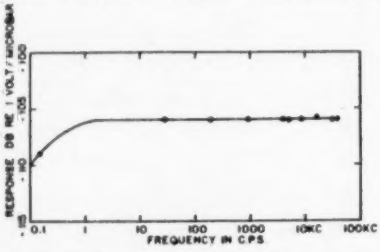

Fig. 6. Pressure response (at diaphragm) in air vs. frequency.

High-frequency response depends to a great extent on design factors, including the rigidity of clamping. Flat response to 30 kc. has been obtained readily in air, and response flat to ± 1 db. to 1000 cps., and ± 3 db. to 5 kc. has been obtained in water with the same transducer. A typical air-response curve is given in Fig. 6 for a baffle-type instrument such as that illustrated in Fig. 1.

Pressure Range, Linearity, and Noise

The same electrokinetic cell is equally suitable for measurements at levels from a few microbars to 100 psi., giving a useful range of over 10^6:1. Higher pressures require the use of auxiliary metallic plugs in the transducer. The usual compromises between natural frequency and sensitivity are not involved in the design.

In tests conducted to date no departures from linearity, not accounted for by measuring uncertainties, have been noted throughout the useful range. Typical calibrations at various pressures are shown in Fig. 7. The tests were conducted and the data furnished by the Explosion Effects Division of the Naval Ordnance Laboratory at White Oak, Md. The lower limit of measurable pressure is determined by thermal or "Johnson" noise, as in any resistive element, which is a function of resistance, bandwidth, and temperature. In most applications it is considerably less than one microvolt and is negligible compared to the signal.

Acceleration Sensitivity

The acceleration sensitivity depends entirely on the density of the cell liquid and the column length. It generally is a few millivolts per G unit, which is small considering the high pressure-sensitivity. By using longer isolated columns of heavy liquids, or weights coupled by means of pistons or bellows, high acceleration-sensitivities can be obtained. Small experimental accelerometers have been constructed with sensitivities of 500 mv./G over frequency ranges extending from 0.5 to over 1000 cps.

Mechanical Impedance

One of the most important features of the electrokinetic transducing element is its high resistive mechanical-impedance. The high flow-resistance of microporous disks or plugs makes it possible to use rugged diaphragms and yet obtain good response to low frequencies. It also reduces the effects of "mass loading" when the transducer is submerged in liquids. At low audible and subaudible frequencies, impedance-matching means or "pressure multipliers" may be employed in the form of pistons, levers, or bellows to obtain substantial power gains. This is important, for example, in geophysical detectors for underwater use. The permeability factor B for ultrafine porcelain is about 5.6 x 10^{-11} centimeters squared, giving a flow resistance per unit area of 735 psi. per inch per second for a ⅛-inch-thick disk. This figure is roughly one hundred times greater than the characteristic acoustic impedance of water.

Operating Temperature Range

The operating temperature range is determined largely by the boiling and freezing points of the liquid and by the hydrostatic pressures encountered. For acetonitrile the sea-level range is limited to between minus 40 and plus 80 deg. C., with 10 to 15 degrees allowed at each end for a safety margin. Liquids suitable for wider ranges, such as propionitrile, can be used to extend the range. For operation at high altitudes, less-volatile liquids are used.

Use with Transformers and Long Cables

The electrokinetic cell is the only known type of self-generating transducer which is pressure (rather than velocity) sensitive and which has a resistive output impedance. The high circuit-impedance and thermal-noise difficulties at subaudible frequencies encountered with piezoelectric devices are largely avoided. Although midband sensitivity is independent of cable length, cable capacity affects the upper frequency-limit. This effect is largest with small transducers, necessitating the use of transformers or cathode followers when long cables are required. Commercially-available geophysical-type transformers can be used for matching electrokinetic transducers to 500-ohm or 250-ohm lines up to several miles in length, thus eliminating the need for preamplifiers.

Miscellaneous Applications

Electrokinetic transducers should be thought of as being inherently pressure sensitive because of their low temperature-coefficient when pressure coupled. Like other transducers they can be modified to measure acceleration, velocity, or displacement. When a spring element is coupled to the cell diaphragm the output at midband frequencies is proportional to displacement. This principle has been employed in a physi-

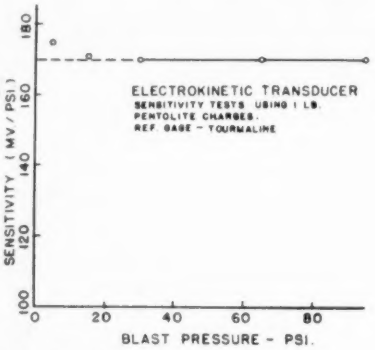

Fig. 7. Sensitivity vs. pressure.

ological research instrument (Fig. 1) designed for measuring relative deflections over the chest wall due to the beating of the human heart. It may also be used in phonograph pickups, surface analyzers, etc. When proper compensation is made for the change of resistance with temperature, electrokinetic transducers may be operated directly into rectifier networks and microammeters or galvanometers without amplification. They are the only pressure-sensitive self-generating transducers which may be directly connected in this fashion.

Conclusions

Electrokinetic transducers are pressure-sensitive devices capable of operating at high or low frequencies and at high or low pressures. They are not suitable for static measurements but can be used at frequencies well below the range of other self-generating transducers. Their high mechanical-impedance and resistive electrical-impedance make possible the use of either electrical or mechanical impedance-matching. Signals may be transmitted over long cables without amplification. Uses include pressure gages, blast gages, physiological instruments, geophysical hydrophones, accelerometers, and others under development. It is expected that electrokinetic transducers will find increasing applications.

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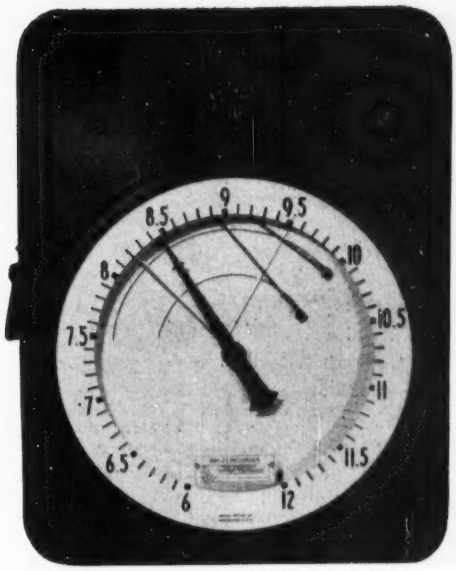
by BAILEY...

Your best buy for Precision Temperature Measurements In the 600F to 1200F Range



Check These Exclusive Bailey Advantages of Resistance Thermometer Operation In Higher Temperature Ranges

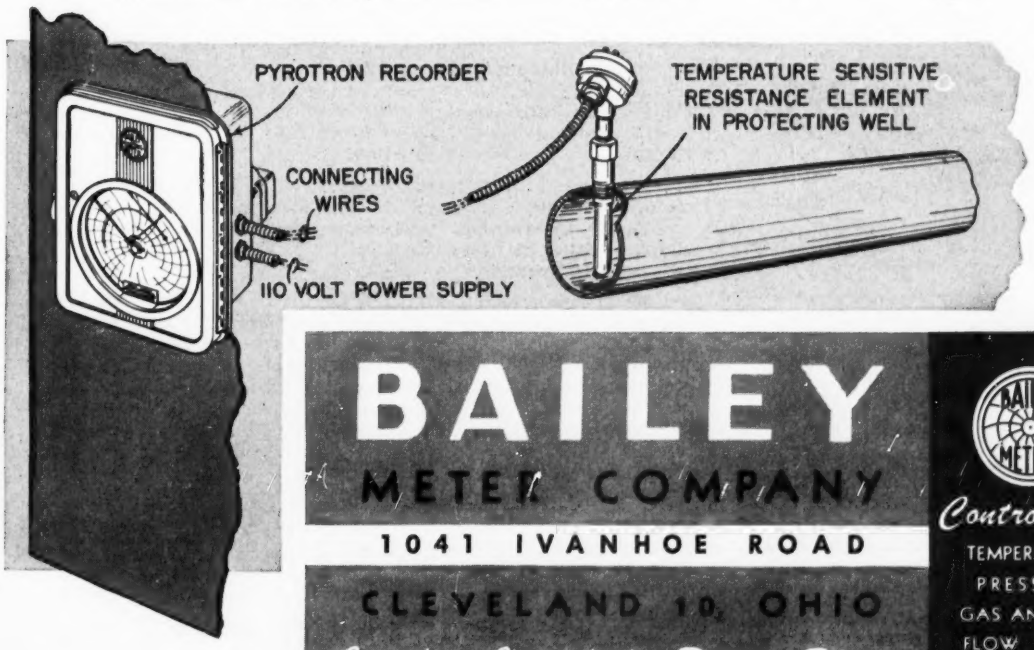
✓ Resistance thermometer operation over a complete range from—300F to 1200F has been made possible by Bailey's development of a low-cost platinum resistance element.

✓ Resistance thermometer operation requires no standard cell, dry battery and cold junction compensator. Uses 115 volt a-c source. Strong signal and high precision of resistance element as compared to thermocouple makes possible the use of narrow range spans.

✓ The Bailey Pyrotron is calibrated at the factory and *remains* accurate; no periodic re-calibrations (for nominal accuracy within 2-3 degrees) required. Since all elements are matched it is not necessary to calibrate each recorder to its element.

✓ Ordinary copper lead wires permit remote location of recorder with respect to the temperature sensing element.

✓ For complete information on the use of resistance thermometers in higher temperature ranges, write for bulletin 230-C on the Bailey Pyrotron Electronic Resistance Thermometer. P-27



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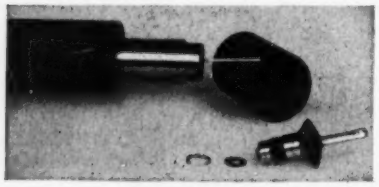
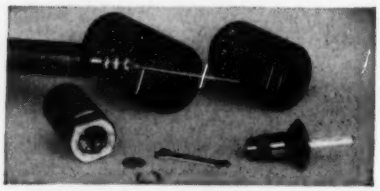
For more information circle 119 on inquiry card.

Tip of Immersion Couple ready for use. Graphite blocks, under spring tension, house the immersion end of the thermocouple element. The "hot" junction projects into the quartz sheath.

First step in replacing sheath. A retractor (not shown) releases the spring tension—exposes the tapered, stainless steel plug into which the quartz sheath is cemented.



After each immersion, the quartz sheath is replaced. Usually, a supply of sheaths, cemented into spare plugs, is kept on hand. Cement comes ready-mixed.



When the junction requires repair, terminal screws are loosened, sufficient wire is drawn down from its storage in the tube, a new junction is formed, and the unit is reassembled.

Simplified Maintenance

SPEEDS REPEATED BATH MEASUREMENTS WHEN YOU USE THE L&N IMMERSION THERMOCOUPLE

● Unique design of the L&N Immersion Thermocouple reduces routine maintenance to a simple operation performed right at the furnace. No time is wasted in elaborate repairs—or in transporting equipment to and from instrument maintenance shops. No valuable storage space is required for numerous stand-by units. No capital is tied up in surplus equipment.

After each immersion in the molten metal, the operator simply replaces the plug-mounted quartz sheath protecting the "hot" junction of the couple, and is ready for the next measurement. When the thermocouple junction itself must be repaired, an adequate length of wire is simply drawn down from the reserve supply in the tube to form the new junction.

Since each unit is normally available on a full-time basis, equipment requirements are reduced. The usual installation consists of only one unit per furnace (with one Speedomax® immersion thermocouple recorder for every two units) and a stand-by unit for every two or three furnaces.

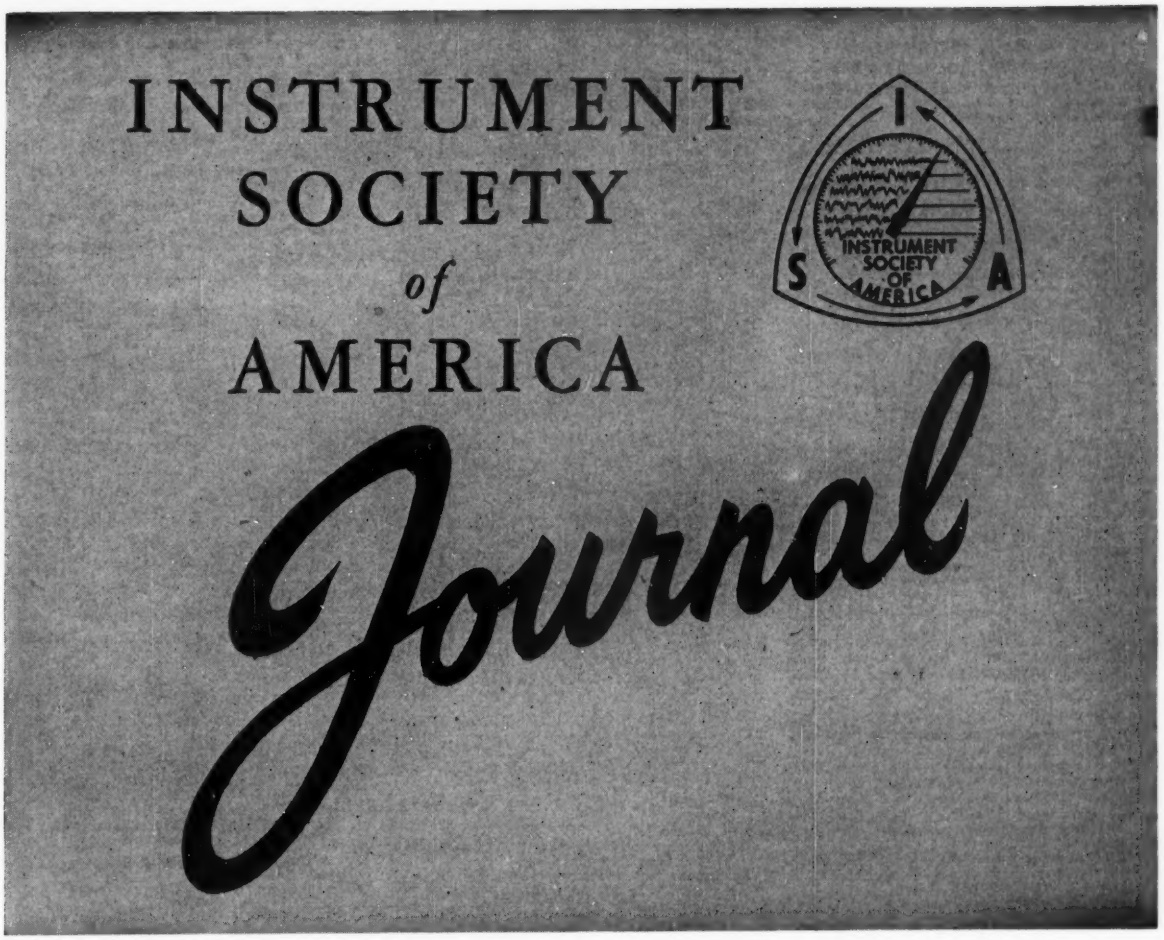
Ease of maintenance is but one feature of the L&N equipment. Accuracy of measurement is protected in various ways. Design of the thermocouple circuit minimizes junction error by putting lead-wire junction at the handle end of the unit. Instrument accuracy is protected by automatic standardization of the recorder measuring circuit during each immersion, only seconds before the immersed couple reaches bath temperature. Simplicity of operation is assured by the Recorder's Signal Light system, which guides the user through each step of the measuring sequence.

For full details, contact your nearest L&N representative, or write us at 4955 Stenton Ave., Phila. 44, Pa. for Process Data Sheet 643(1).

LEEDS [LN] NORTHRUP

instruments — automatic controls • furnaces

For more information circle 120 on inquiry card.



National Office: 1319 Allegheny Avenue, Pittsburgh 33, Pa., P V. Jones, Jr., Society Manager.

Vol. 9 AUGUST, 1953 No. 8

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CONTENTS

Sections Data 1192

ISA News 1193

Employment Service 1193

Instrumentation's Place in the Managerial Organization 1194
By Robert H. Berg

Tentative Technical Program for Eighth National ISA Conference 1200

Section Secretaries, Meeting Data and Programs

AKRON
Russell F. Marquardt, 1782 Tonawanda Ave., Akron 5, Ohio. Tel: ST-6865
Fourth Tuesday, Meeting 8:15 P. M.

ALBUQUERQUE
A. Richard Charlton, 1229 Girard Blvd. N. E., Albuquerque, New Mexico
Second Thursday, Meeting at 8:00 P. M.

ARUBA
M. A. Davidson, P. O. Box 452 c/o Lago Oil & Transport Co. Ltd., Aruba, N. W. I., 2087.
First Tuesday, 7:30 P. M., Engr's Club.

ATLANTA
Roy W. Freeman, Minn.-Honeywell Reg. Co., 1415 Howell Mill Rd., Atlanta, Ga. Tel: AT 9776
Fourth Friday, Meeting 7:30 P. M.

BALTIMORE
G. B. Greer, 631 East 36th St., Baltimore 18, Md. Tel: CHesapeake 6879
Second Friday, Meeting at 8:30 P. M.

BATON ROUGE
Thomas J. Folendore, 1540 Keed Avenue, Baton Rouge, La. Tel: 3-5567
First Monday, 7 P. M.

BLUE RIDGE
David C. Moore, Box 425 B RFD #4, Roanoke, Va.

BOSTON
E. E. Forslind, Stone & Webster Eng. Corp. 49 Federal St., Boston 7, Mass. Tel: Ha-6-2500 Ext. 821.
Fourth Wednesday, Dinner 6:30 P. M. Meeting 7:30 P. M. 99 Club, 99 State St., Boston.

CALIFORNIA
Robert W. Fulwider, 5225 Wilshire Blvd., Los Angeles 36, Calif.
Second Wednesday, Dinner at 6:30 P. M. Meeting at 8:00 P. M.

CAROLINA PIEDMONT
H. M. Messenger, 436 Sedgefield Rd., Charlotte, N. C.
Second Friday, Dinner at 7:30 P. M., Meeting at 8:00 P. M. Cardinal Restaurant, Charlotte.

CENTRAL ILLINOIS
Eric B. Bensing, 1100 Hanssler Pl., Peoria, Ill.
Second Wednesday, 7:30 P. M.

CENTRAL INDIANA
Leon Stewart, Rock Island Refining Corp., P.O. Box 6091, Indianapolis, Ind. Tel: CO-2377
First Tuesday, Dinner at 7:00 P.M. Business Meeting 8:00 P. M.

CENTRAL NEW YORK
C. M. Davies, 213 Beechwood Ave., Liverpool, N. Y. Tel: Syracuse 3-0252.
Third Monday, Dinner 6 P. M. Meeting at 8.

CENTRAL OHIO VALLEY
J. C. Dilliner, 813 Winton Ave., Belpre, Ohio. Tel: Belpre 87596
First Tuesday, Dinner at 7:30 P. M., E.S.T., Hi-Way Grille, Rt. #2.

CHARLESTON
J. A. Rothwell, 310 24th St., Dunbar, W. Va.
First Monday, Dinner at 6:15 P. M., Meeting at 8:00 P. M., Kanawha Airport Terminal

CHICAGO
Floyd E. Ertsman, Rm. 1420, Fisher Bldg., 343 S. Dearborn St., Chicago 4, Ill. Tel: WE 9-0686
First Monday, Dinner at 6:30 P. M., Meeting at 8:00 P.M. Hotel Shoreland, Chicago, Ill.

CHINA LAKE
Beuhring W. Pike, 606-A Essex Circle, China Lake, Calif. Tel: 77782
Third Thursday, Meeting at 8:00 P. M.

CINCINNATI
Richard E. Surkamp, 7347 Richmond Avenue, Cincinnati 36, Ohio.
First Monday, Dinner at 6:30 P. M., Meeting 8:00 P. M., Engineering Soc. of Cinn.

CLEVELAND
R. C. Van Hala, %Van Hala Industrial Co., P. O. Box 2602, Lakewood 7, Ohio
Second Wednesday, Dinner at 6:30 P. M. Meeting at 8:00 P. M.

COLUMBUS
Kenneth I. Lea, Battelle Institute, 505 King Ave., Columbus 1, Ohio Tel: UN-3191, Ext. 247.
Third Thursday, Meeting at 8:00 P. M. Battelle

CUMBERLAND
Clyde Babst, 225 Cecelia St., Cumberland, Md. Tel: 583-W
Fourth Wednesday, Dinner at 6:30 P. M., Meeting at 8:00 P. M.

DENVER
Karl F. Kent, Jr., 5030 Umatilla, Denver 11, Colo. No regularly scheduled meetings. Univ. of Denver, Science Bldg.—Campus

DETROIT
Philip Hill, Minn.-Honeywell Reg. Co., 13631 Plymouth, Detroit 27, Michigan
Third Wednesday, Meeting 8:00 P. M.

EASTERN NEW YORK
Robert W. Carter, Sterling-Winthrop Research Institute, Rensselaer, N. Y. Tel. Albany 5-6251 Ext. 262
First Tuesday, Meeting at 8:00 P. M., Siena College, Loudonville, N. Y.

FOX RIVER VALLEY
John R. Redgrave, 109 S. Appleton St., Appleton, Wis.
First Tuesday, 8:00 P. M.

HOUSTON
A. Costa, 6209 Edloe St., P.O. Box 6614, Houston, Texas.
Last Monday 8 P.M. U. of Houston Library

KALAMAZOO VALLEY
Jack M. Fettig, 433 Thomas St., S.E. Grand Rapids, Michigan.
Fourth Wednesday, 8:00 P. M., Dinner at 6:30 P. M. Meeting at Red Arrow Legion Post.

KANSAS CITY
Donald D. Baker, 5823 Mission Rd., Mission, Kansas
First Tuesday, Meeting at 7:30 P. M., U. of Kansas City, Science Bldg., Rm. 106.

LAKE CHARLES
A. T. Clinger, Columbia Southern Chemical Corp., P. O. Box 900, Lake Charles, La. Tel. 6-7522
First Wednesday after last Monday, Dinner and regular meetings at McNeese State

LOUISVILLE
O. Vern Spousta, 2000 S. Brook St., Louisville, Ky.
First Monday, Meeting at 8:00 P.M., Seagram Auditorium.

MILWAUKEE
N. J. Janisse, Johnson Service Co., 507 E. Michigan St., Milwaukee 2, Wisconsin.

MONTREAL
W. L. Toohey, Dominion Textiles Ltd., 1950 Sherbrooke St., West, Montreal, Tel. GI 5711
Last Monday of month, Meeting 8:00 P. M.

MUSCLE SHOALS
Atherton Hastings, TVA, Div. of Chemical Engineering, Wilson Dam, Alabama. Tel: Sheffield 3160, Ext. 6238
First Thursday, Meeting 8:00 P.M., TVA Chemical Engineering Bldg.

NEW JERSEY
Eliot R. Hill, 1125 Kensington Ave., Plainfield, N. J.
First Tuesday, Meeting 8:00 P. M., Essex House Hotel, Newark, N. J.

NEW YORK
R. A. Hutcheon, 45-65 196th St., Flushing 58, N. Y., Tel: BAyside 9-5432
Third Monday, Dinner at 6:00 P. M., Meeting at 7:30 P. M., Midston House, 38th St. & Madison Ave.

NIAGARA FRONTIER
Duran L. Hagler, 214 E. Delavan Ave., Buffalo, N. Y., Tel: ELmwood 1258
Fourth Monday, Dinner at 6:00 P.M. Meeting at 8:00 P.M., N.Y.S. Technical Institute.

NORTH TEXAS
R. E. Byers, 6000 Lemmon Ave., Dallas 9.

NORTHEAST TENNESSEE
James L. Williams, 1617 Carolina Avenue, Kingsport, Tenn. Tel: 2079 L

NORTHERN CALIFORNIA
Robert L. Norman, 351 42 St., Richmond, Calif. Tel: BE 2-0901
Third Monday, Meeting 8:00 P M.

NORTHERN INDIANA
J. B. Beckman, 7145 Wicker Ave., Hammond, Ind. Second Tuesday, Meeting at 8:00 P. M., Whiting Community Center, Whiting, Ind.

OAK RIDGE
Thomas M. Gayle, 117 W. Vanderbilt Drive, Oak Ridge, Tenn. Tel: 2-1516.
First Wednesday Meeting at 7:30 P. M.

OGLETHORPE
J. R. Upson, 213 54th Street, Savannah, Georgia
Second Friday, 8 P. M. Reddy Kilowatt Room, Savannah Electric and Power Company.

PADUCAH
J. B. Russell, Carbide & Carbon Chemicals P. O. Box 748, Paducah, Ky. Tel: 5-6311—Ext. 403
Second Tuesday Dinner at 6:30 P. M. Meeting 8 P. M.

PANHANDLE
George W. Leggett, 1600 Western Ave., Amarillo, Texas.
Third Tuesday, Dinner at 7:30 P.M. Phillips Grade School Cafeteria, Phillips, Texas

PERMIAN BASIN
Jack M. Ray, P.O. Box 1386, Odessa, Texas
Second Tuesday, Dinner at 8 P.M. Tel: 2-2813

PHILADELPHIA
A. S. Chatfield, c/o American Meter Company, 1513 Race St., Philadelphia 2, Pa.
Elks Club, 1320 Arch St., Dinner at 6:30 p. m., program at 7:30. Third Wednesday.

PITTSBURGH
Dr. A. H. Peterson, Mellon Institute, 4400 Fifth Ave., Pittsburgh 13, Pa. MA 1-1100
Fourth Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Roosevelt Hotel

PRESQUE ISLE
F. L. Moore, American Meter Co., 920 Payne Ave., Erie, Pa.
Fourth Tuesday, Meeting at 8:00 P. M.

RICHLAND
J. R. Plee, 1309 Roberdeau, Richland, Wash. Tel: 5-8692
Second Wednesday, Meeting at 7:30 P. M.

ROCHESTER
R. C. Schwarz, Jr., 1201 Granite Bldg., Rochester 10, New York. Tel: Hamilton 1468
Fourth Tuesday, Meeting 8 P.M. U. of R., Bausch & Lomb Physics Lecture Room 109.

SABINE-NECHES
R. A. Block, 2301 Avenue "G", Nederland, Texas
Last Tuesday, Meeting at 7:30 P. M., Orange County Courthouse, Orange, Texas.

SARNIA
L. J. Hall, 730 Talfourd St., Sarnia, Ont., Canada. Tel: EDgewater 2258.
Third Monday, 8:00 P.M., Y.M.—Y.W.C.A.

SAVANNAH RIVER
F. P. Ledford, Jr., 907 Royalette St. N. Augusta, S. C., Tel: 5-4626
Second Wednesday, Dinner at 7:30 P.M. North Augusta Legion Post.

SEATTLE
Frank S. Melder, 2439 76th N.E. Bellevue, Washington, Second Friday.

SOUTH TEXAS
Homer C. Givens, P.O. Box 637, Falfurrias, Texas. Tel: 202
First Thursday, Engineers Club

ST. LOUIS
W. G. Lee, 4710 Delor St., St. Louis 16, Mo. Tel: FL 8516.
First Wednesday After First Monday, Meeting at 8:00 P. M.

TOLEDO
Howard R. Daily, 2025 Scottwood Ave., Toledo, Ohio.
Third Tuesday, Meeting at 8.00 P. M.

TORONTO
John W. Huether, 311 Sutherland Dr., Leaside, Ontario, Canada. Tel: HU-7114
Fourth Thursday, Meeting at 8:00 P. M.

TULLAHOMA
B. A. Artz, RFD #2, Tullahoma, Tenn.

TULSA
A. J. Sesock, 845 South East Ave., Tulsa, Okla., Tel: 8-1112
First Monday, Meeting at 7:30 P.M.

TWIN CITIES
John L. Schmidt, 1879 University Ave., St. Paul 4, Minn., Tel: DR 0064
Fourth Tuesday, Dinner at 6:30 P.M., Meeting 7:30 P. M.

WASHINGTON
Edward C. Lloyd, 2105 Spencer Road, Silver Spring, Md. Tel: SH. 9340.
Third Monday, Meeting at 8:00 P. M.

WAYNE COUNTY
Clarence Ellison, 2443 15th St., Wyandotte, Michigan. Tel: Avenue 2-4178.
Third Monday, Meeting at 8:00 P. M.

WICHITA
J. W. Rieg, c/o Koch Engineering Co., Inc., 321 W. Douglas Ave., Wichita 2, Kansas
Third Thursday, 8 P. M. Scientific Bldg.

WILMINGTON
W. C. Ruglass, 900 A West 8th Street, Wilmington, Delaware
Second Tuesday, 8:00 P. M. Harlan School.

ISA To Co-sponsor Sixth Conference on Electronic Instrumentation in Medicine And Nucleonics

The Instrument Society is, for the first time co-sponsoring with AIEE and IRE, the sixth Annual Conference on Electronic Instrumentation in Medicine and Nucleonics to be held in New York City on November 18-19, 1953.

S. R. Gifford, Chairman of the Planning and Program Committees, announced that a meeting would be held at the AIEE headquarters in New York City on July 22nd, during which time the papers for the program will be selected and the Conference organized.

ISA NEWS

Chicago Section ISA 1953 Host Committee

Top Row (l to r) O. M. Haseltine, G. A. Larsen, A. F. Sperry, R. P. Sunderland, J. C. Freyberg.
Second Row (l tor) J. B. McMahon, Chas. Ament, M. D. Shriver, D. S. Dickey, J. H. Cuthbert, E. S. Bush.
Bottom Row (l to r) Chas. L. Saunders, A. Hudson, R. R. Proctor, P. R. Dickson.

An Open Letter to All Members:

Greetings from Chicago! No doubt many of you are planning to attend the Eighth National Instrument Conference and Exhibit to be held in Chicago this coming September 21-25. This letter, frankly, is an appeal for help at this Conference. Since registration desks will be operating in two hotels (the Sherman and the Morrison), and since we expect one of our largest registrations to date, we find it necessary to provide an unprecedented number of workers on the Reception and Publicity Committees. We would like to have enough members on these committees under the direction of our local chairmen so that no one person will have to serve more than four or five hours during the entire week of the Conference.

Can you help us out by volunteering your services for four hours (or more, if you like) sometime during the week of the Conference? You may state your preference as to committee, number of hours, day of the week, time of the day, and hotel, and we will do our best to schedule each of you according to your desires.

The Reception Committee, directed by Mr. Hank Havens of the Chicago Section, is to be made up of four-man teams, each under the supervision of a Chicago "captain." Each team will serve four hours, with one team on duty in each of the two hotels at all times. The duties of the members of this committee are simply to be on hand near the registration desks to answer questions, direct registrants to the meeting rooms, exhibits, information center, pre-print sales, employment register, ladies' headquarters, etc., etc.

The Publicity Committee, under the chairmanship of Chicago's Diamond Dickey, needs at least two men on duty at all times in the "Press Headquarters" to meet the press representatives, hand them the "Press Kits" prepared by the National Office, direct them to the Exhibits, locate people whom they might wish to interview, conduct them through the Exhibit or to any booth they particularly desire to see, etc.

The duties of the members of both of these committees are light and extremely interesting. However, to avoid overloading a few persons, the job takes a lot of man-power, and most of the Chicago Section members are already assigned to these and the numerous other committees now being organized.

Volunteers, please drop me a line as soon as possible if you can assist us.

We'll be seeing you in Chicago in September.

Sincerely yours, R. R. PROCTOR, General Chairman, 1953 Conference Host Committee (192 Pomeroy Ave., Crystal Lake, Illinois.)

EMPLOYMENT SERVICE

Forward your letter to ISA
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Pittsburgh 33, *Pa.*

DISTRIBUTOR WANTED: To merchandise a complete line of Industrial Thermometers, Mercury Thermostats and Hydrometers. This manufacturer is recognized as A-1 in the industry and wishes to expand its distribution. Will welcome inquiries from responsible principals. Box 822.

ELECTRICAL ENGINEERS: Several positions in our Research Development and Design Departments for men with E. E. degrees and one to five years' experience in electronic or electrical circuit design. Experience in instrumentation or in control circuits is preferred. Excellent benefit programs and working conditions. Brochure available. Send resume. Location: North Philadelphia, Pa. Box 823.

INSTRUMENTATION. Degree in electronics plus about five years experience in circuit design or instrumentation. Would be responsible for the design and development of flight research instrumentation for performance data and control. A knowledge of "hardware" and an ability to work with same is required. Box 824.

TACTICAL PHOTOGRAPHY. Degree in electronics plus about seven years experience in experimentation and instrumentation for physical research. Must have a knowledge of problems (and solutions) associated with the tactical use of photography. Box 825.

RADAR AND PHYSICAL INSTRUMENTATION. Staff positions are open for men with advanced degrees in electronic engineering, or physics with experience in electronics, which will qualify them for research where electronic instrumentation and apparatus play a vital role. Fields of physics involved are radar automatic control, atmospheric physics, and computers. Box 826.

DYNAMIC CONTROL SYSTEMS. Would be responsible for technical direction of large and complex development projects. Emphasis will be on control systems, but also will work in one or more of the following areas: communications, production design practice, radar, computers (analog &/or digital), electrical measurements and instrumentation. Box 827.

MISSILE GUIDANCE. This includes study, design, analysis, simulation, test and operation of components and complete systems. Test work includes breadboard, environmental and flight. Box 828.

INDUSTRIAL CONTROLS. Seven years of experience minimum. Would be responsible for both technical effort and customer liaison. Must have broad knowledge of industrial electronics. Box 829.

INSTRUMENTATION. Recent B.S. or M.S. with experience in construction of electronic gear. Would work on design, installation and testing of special control and recording equipment for installation in aircraft. Box 830.

JUNIOR ENGINEER. A recent graduate with good grades and a liking for experimental work. Box 831.

PRINCIPAL ENGINEER. Education should be equivalent to M.S. in Aeronautical or Mechanical Engineering. Formal study should have included courses in advanced engineering mathematics, applied mechanics, structural design and electrical circuits. At least ten years of design experience are required in one of the following fields: aircraft, missile, rocket, armament or servomechanism. This experience should include preliminary design, project engineering, testing and analysis of the completed product. Box 832.

WIND TUNNEL OPERATION. This is an excellent opportunity for young men with an aeronautical option or degree to enter the field of wind tunnel operation. After a short period of informal training, the graduate would receive the assignment of assistant project leader. In this post he would assist in the planning of

Continued on page 1199

Instrumentation's Place in the Managerial Organization

By ROBERT H. BERG*

Abstract. Toward the end of shaping the most effective instrumentation department, this paper considers the important question: "Where is the right spot for instrument service in management's organization chart?" A fundamental component of process plant organizational structure is proposed, in which instrument service is one of several functions of an intelligence department comprising all forms of technical measurement, reporting and quality control. Analogy is made with advanced trends in instrumentation, in which a monitor network serves the analysis and control systems.

Instrument service (including application and maintenance), analytical laboratory, statistical control reporting, raw materials and product inspection, and quality control are covered as components of this unified agency. Supporting discussions analyzing the advantages of such functional association are included.

THE expanding significance of instrumentation throughout industry has been a favorite topic of technical groups in recent years. There is no denying that automatic measurement and control are here to stay. Consequently, there has been much accomplished and many papers written concerning the development of instrument service facilities and the training of instrument technicians and engineers.

But apparently instrumentation has been growing so rapidly we haven't had a chance to keep pace with its need for adequate placement as a component of management. Too often, there is need for a more fully appreciative line of authority for achieving sound objectives. This, even though many companies have well-developed instrument departments. Conversely, management is frequently unable to properly evaluate the problems of instrumentation, and the full potentialities of both remain unrealized. All groups concerned have had frequent occasion to disparage this situation.

Thus, to serve both management and instrument service to best advantage, instrument men and managers must answer an important question: "*Where is the right spot for instrument service in management's organization chart?*"

Functional Unification the Basic Answer

Consideration of this problem reveals certain parallels between instrument service and such process plant functions as materials inspection and the analytical control laboratory. All told, the common objectives consist of monitoring plant technical performance and maintaining the systems and tools of measurement and control.

Application engineering and maintenance of measurement and control equipment are the major functions of instrument departments. But they are also assigned, on occasion, such duties as preparing plant production and service distribution reports, keeping plant downtime records, and repairing business machines and communication systems. Thus, several agencies provide the measurement and control services that management *at all levels* needs for making technical decisions from considered comparisons between what is desired and what is being done.

It is therefore proposed that, collectively, all measurement and control services be regarded as one fundamental technical intelligence component of process plant organizational structure. For maximum efficiency and effectiveness, these activities should be organized under one head as a separate service department, as are plant engineering, industrial relations, and accounting — reporting directly to top plant management.

In most present-day processing plants, this means the integration of several loose ends into one logical, coordinated function. Considering production industries, in general, we may perceive several basic components of technical intelligence service, namely:

(1) Inspection and analysis of raw materials.

(2) Evaluation of product characteristics in process.

(3) Analysis and control of product quality and quantity.

(4) Monitoring of operative and equipment performance.

(5) Application engineering and maintenance of manual and automatic measurement and control equipment, comprising the enabling tools of the technical intelligence function.

(6) Process appraisal and development of improved standards and efficiency.

For a given plant, these agencies may be sub-grouped according to the particular requirements of processes and personnel abilities, but their mutual purposes are best coordinated by functional unification at the top.

Precedents and Analogies

Such a service has strong precedent in the mechanical fabrication industries, where in recent years the development of statistical quality control, with inspection and gage laboratory services, has provided management with an efficient tool for making technical decisions. Throughout industry, a parallel financial service has long been established in the form of cost and accounting departments. A well-organized management control system covers materials and machines, as well as men and money.

For fuller comprehension of this concept, we may make forceful analogies through well-developed principles of automatic control and cybernetics, which correlates communication and control in animals and machines. The feedback control loop is a fundamental tool in all fields concerned with the method by which control is achieved. Instrument men are especially familiar with it in one form or another. As shown in Fig. 1, the essential pattern is to:

(1) *observe* a condition of the environment,

(2) *decide* how the observation compares with a reference (desired) condition, and

(3) *act* in an appropriate manner to maintain the desired condition.

As the "natural way" of doing things, any unit or group of brains or machines capable of corrective response to stimuli follows this behavior pattern. Since the human mind is a controller, this simple sequence is readily understood. We all operate this way whether we realize it or not.

*Process Control Engineer, International Minerals & Chemical Corp., Chicago, Ill. Now with Process Control Services Co., Elmhurst, Ill.

An interesting parallel may be made with advanced trends in today's thinking regarding automatic controls. Proposed control systems involve a single scanning and monitoring instrument which continually measures and evaluates all of the variables in the plant as transmitted from hundreds or even thousands of measuring instruments in the plant. Deviation of a variable from its assigned limits results in actuation of recording and control systems which then bring the variable back in line. Similarly, the plant measurement and control service would serve as an impartial monitor for management, the controller.

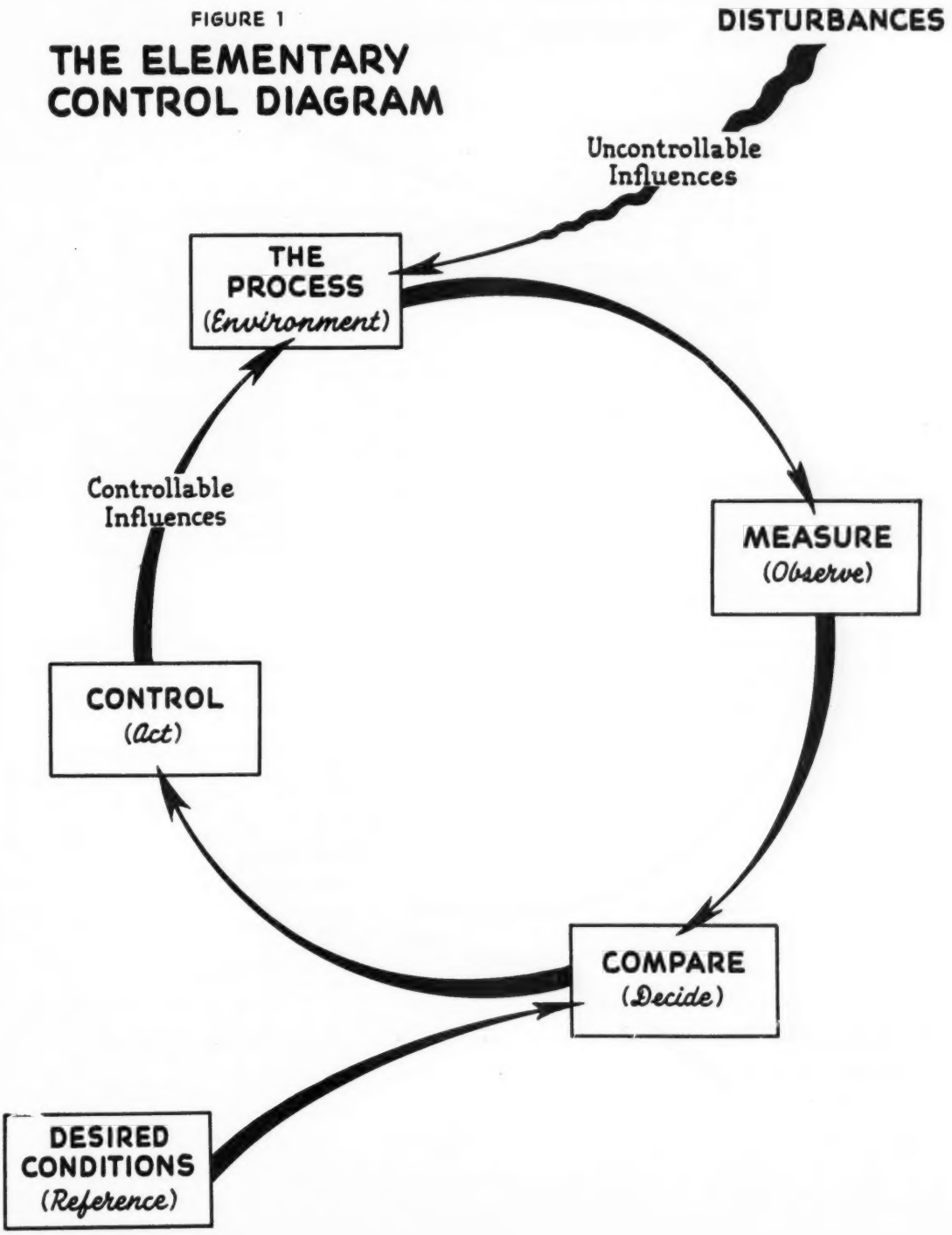
Fig. 2 shows how easily and naturally this scheme applies to the management of an entire processing plant from the technical standpoint. Since the application of automatic control has advanced so rapidly in the process industries, it seems appropriate to make this analogy with the elementary control loop employed in process regulation.

Management's View

Primarily, Fig. 2 represents the normal, functional basis for plant process control and organizational structure.

FIGURE 1

THE ELEMENTARY CONTROL DIAGRAM



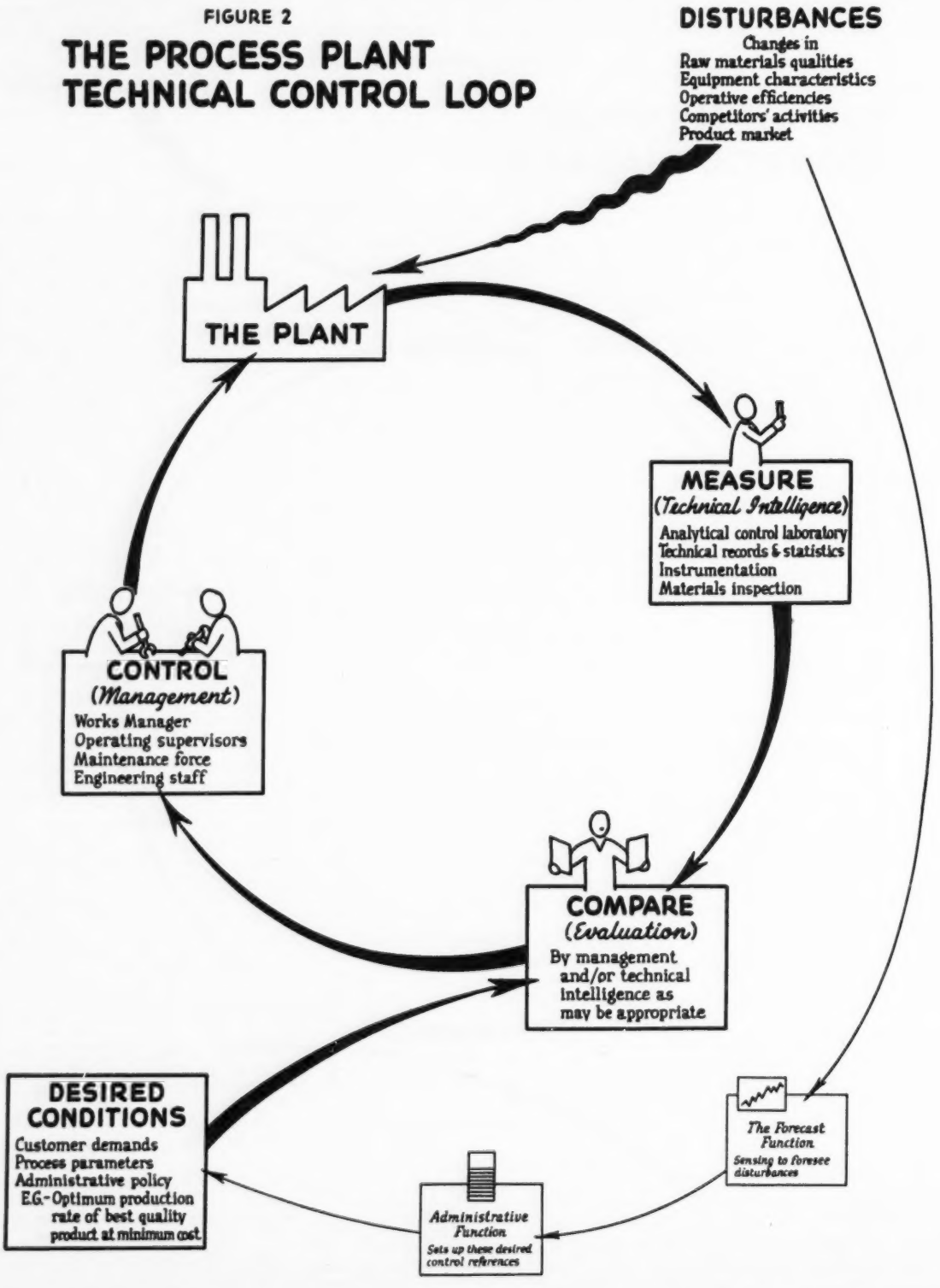
In many plants today, organizational trends are clearly in this direction. Good management is good control, and good control depends on good measurement. This is true for any organized plan for managerial control.

With coordinated measurement and control services, proper importance may be given to each, and we simplify the managerial system by minimizing the number of departments reporting directly to the plant manager. This is recognized as good practice in shaping effective organization charts.

We may readily reconcile various

FIGURE 2

THE PROCESS PLANT TECHNICAL CONTROL LOOP



relevant procedures and parallel systems with this plan.

As indicated in Fig. 2 with forecasting and policy-making, auxiliary and by-pass circuits may often exist in conjunction with the operational control loop, which also includes a multiplicity of lesser sub-loops. For example, operators make direct observations and take decisive action in many routine matters; the analytical laboratory often specifies ingredient proportions and other such factors affecting quality; automatic controls assist operators in many tasks, both difficult and routine; and supervisors take desired on-the-spot measurements for urgent control action. All of these procedures fit in smoothly with the proposed organizational structure.

Thus, the measurement and control service is seen as a well-defined component of plant technical control and an essential member of the management team. Working diagrams more-or-less comparable to Fig. 2 might be devised for other functions such as accounting, sales, research, and engineering. Coordination of the measurement and control service with these other functions will establish appropriate operational boundaries and interlocks. Engineering and accounting are perhaps the closest associate services.

The man to head the technical monitoring service of a process plant represents an expanded concept of what has been called a systems engineer. A good manager and supervisor, this man is also an experienced technician with a sound knowledge of measurement and control fields comprising instrumentation, process engineering, quality control, and technical reporting. Although not necessarily expert in all, his background may well be in one or more of these fields. Thus, interesting opportunities and responsibilities may be waiting for the instrument man, process engineer, or quality control technician who becomes qualified.

An Example

Figs. 3 and 4 picture a "before and after" application of the proposed concept to a typical plant organization chart. Naturally, there are a great many different chart arrangements in use today for plants of various sizes and purposes, but Fig. 3 may rightly be considered a representative, well-planned chart, in conformance with modern concepts of managerial organization.

Note, however, the scattered emphasis and distribution of technical monitoring functions, as indicated by arrows on Fig. 3. Not only is effective communication between component activities hindered, but also we have repeated cases of operating sections measuring and reporting on their own efforts, which theoretically prevents true control of operations.

In Fig. 4, the single arrow shows how these scattered functions could be neatly and logically grouped under one head. The result is a simpler organization, with fewer men reporting to the manager, which is a desirable situation. Of course, the actual conversion from Fig. 3 to Fig. 4 would be a planned, gradual operation, as dictated by the particular circumstances in a given plant.

Advantages

In addition to the foregoing organization chart simplification, the chief benefits to be realized are (1) *impartiality*, (2) *efficiency*, and (3) *flexibility*. Although such advantages are somewhat intangible in dollars and cents, each may be amplified as follows:

(1) *A greater degree of impartiality* in technical monitoring is alone sufficient justification for functional unification. Objective specialization and broader perspective minimize bias in the choice of variables and correlation of data, and smooth the way to effective control. Not only are correct decisions more readily made, but also performance levels are more clearly evident.

Presently, measurement and control services are often distributed among

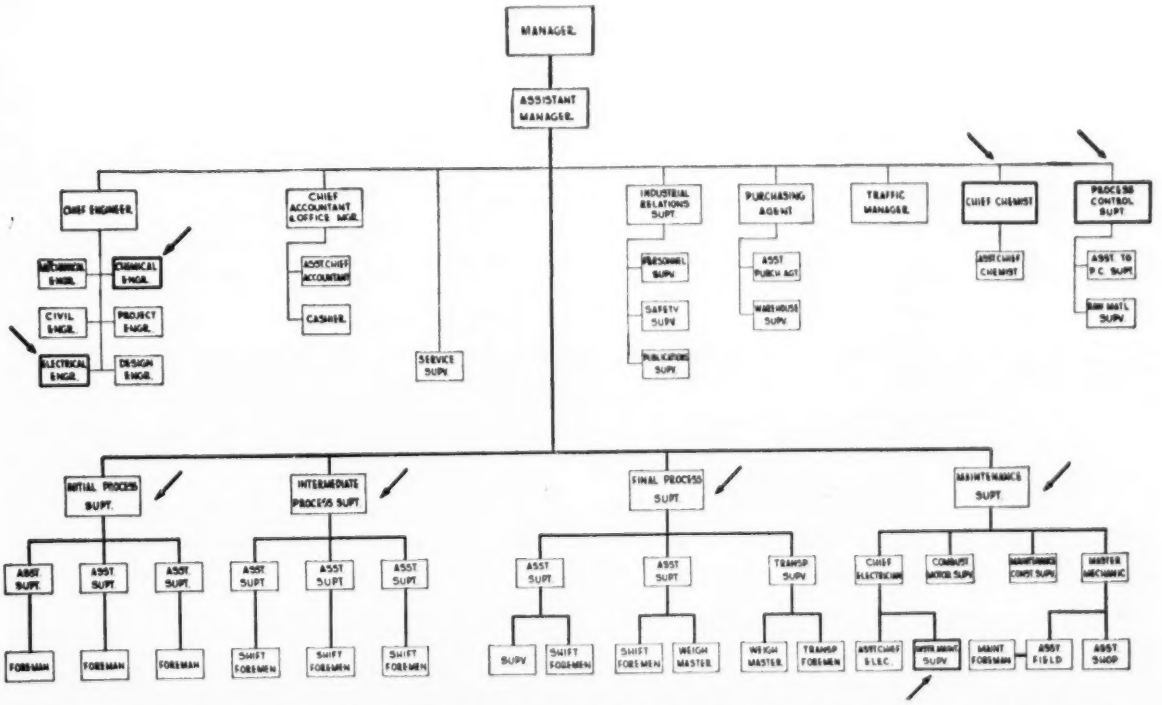


Fig. 3. Typical Organization Chart before application of proposed principle. Arrows point out scattered monitoring functions.

several departments of the process plant organization. When departmental superintendents keep separate technical performance records and direct their own measurement and control activities, they are liable to serve particular, rather than general, purposes due to their proximity to their own problems. Anything short of an impartial, all-purpose viewpoint lessens the effectiveness of measurement and control activities.

(2) *Improved efficiency* is afforded by functional unification of technical monitoring. Much work simplification results from such consolidation, as duplication of effort and the use of valuable technicians for routine work are minimized. Also, we reduce management's task of coordinating information and free their hands for other important work, as a result of being able to place highest confidence in the centralized technical intelligence system.

A unified service will consistently determine, with the cooperation of others, the degree of accuracy required in each given measurement. Also, the application of modern mathematical tools to process control can be given more attention, and effectively used to yield more precise evaluations of information. Through considered selection of key measurements and adequate records for process control systems, we can better avoid situations where inadequate data force us to make too rough estimates regarding important potential developments. And there will be a surer preservation of continuity in the measurement and control aspects of engineering and development projects, right on through to their establishment in permanent operation.

(3) *The general flexibility* of this plan permits adaptation wherever a group of people combine their talents to operate a process plant. It may be applied to the largest and smallest production units alike, with any proportions of human and mechanical operators. Depending on the nature of the process under consideration, the component activities of technical monitoring may assume virtually any pattern of importance-distribution or subgrouping. The important point is that, functionally speaking, these operations are natural bedfellows in any plant.

This organizational plan allows ready assimilation of new developments in process control. Present trends indicate increased automation in the future. Indeed, it has been said that continuous bulk processing will be the first industrial group to be completely robotized. This is because, compared to mechanical fabrication plants, bulk processing plants have a limited number of variables to be measured and controlled by relatively standardized means.

Instrument Service an Essential Component

Of necessity, the application and care of instruments, the tools of measurement and control, must be integral with the services which they facilitate. The vital need for dependability in this comparatively complex class of equipment demands that the measurement and control service have surveillance over instrument engineering and maintenance. Such close alliance will maximize effective instrument utilization and otherwise support the advantages of unified technical monitoring.

This is especially true for the future, as more and more instrumentation is used. Analytical control laboratory routines are being simplified or eliminated as new analyzing instruments are developed. Computing machines now available handle great masses of data and correlate them rapidly and accurately. Application of similar devices to process control is beginning now and may spread rapidly.

Now let us examine this proposed placement of instrument service in the light of past and present practice. In today's plants, instrument engineering and maintenance are generally grouped with established engineering and maintenance departments. But instrumentation bridges all fields of technology, and is important to all technicians. Hence, considerable latitude is afforded

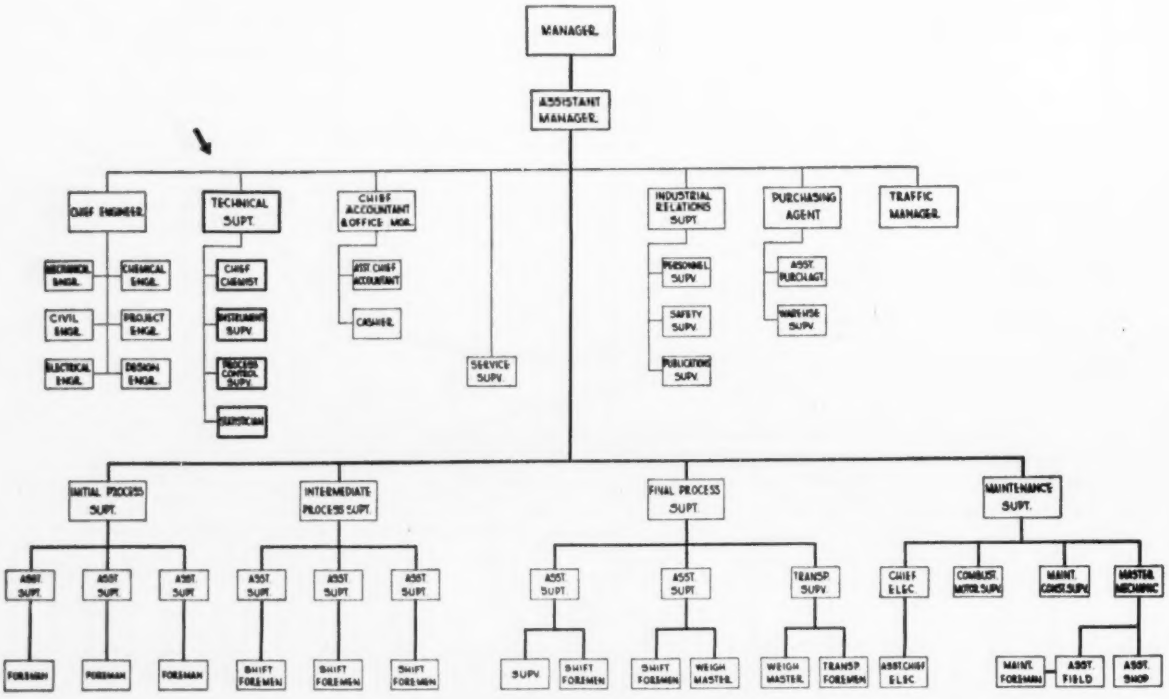


Fig. 4. Organization Chart after application of proposed principle. Single arrow shows where monitoring gathered at one point.

for the organizational association of instrumentation. In listing the advantages of functional association of all measurement and control activities, we imply that most alternative plans leave something to be desired when they face the practical "does-it-work" test.

To realize the maximum benefits of instrumentation, appreciative supervision of instrument service is necessary. This is frequently not the case when instrument maintenance is under general crafts supervisors who may have little knowledge of the science of measurement and control. The background and training requirements for instrument technicians of first-class capabilities surpass those of the more familiar crafts, such as mechanic, electrician, and pipe-fitter. The instrument man must have certain skills in all of these fields, and a sound comprehension of basic physics and mathematics. Thus, the instrument shop may be physically located near other maintenance facilities for convenience, but should be organizationally a part of the over-all technical monitoring function.

ACKNOWLEDGEMENT

The author expresses appreciation to R. L. Logan and T. M. Ware for their helpful suggestions and reviews.

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(*Continued from page* 1193)

test programs and instrumentation requirements for model tests and airflow calibrations. Actual experience will also be gained in the supervision of data reduction, analysis, and report preparation. Box 833.

MECHANICAL INSTRUMENTATION. Three to five years of experience (varied and responsible) including such areas as machine design, strength of materials, dynamics, stress analysis, structures, analytical mechanics, applied elasticity, kinematics, thermodynamics and descriptive geometry. This position is best filled by a man with broad interests who has the abilities and interests necessary to work on a large variety of challenging problems. Box 834.

JUNIOR ENGINEER. Recent graduate with B.S. in aeronautical or mechanical engineering. To assist in research and development of mechanical or hydraulic devices for aircraft or automotive use. In this position he would assist in design analysis and test and would gain experience in test procedure, collection of data and report preparation. Box 835.

AIRCRAFT INSTRUMENTS ENGINEER: Excellent position for engineering graduate with several years' experience in diaphragm aircraft instrument design. This is a position with a progressive organization. Location: Cincinnati, Ohio. Box 836.

Irene Grace

It is with deep regret that the National Office announces the death of Irene Grace, wife of Ed. Grace, Chairman of the National Meetings Committee of ISA. Mrs. Grace died July 20th. She was an active member of the Society.

Computer Data Handling Committee Organizes

The ISA Computer Data Handling Committee met at the Edgewater Beach Hotel in Chicago on May 22, 1953.

The permanent objectives of this Committee were discussed and all members present agreed to postpone final adoption of the Committee's objectives until the next meeting to be held during the Convention.

The Committee now consists of eight members who represent various types of activity in the computer field. An endeavor will be made to solicit more members for representation from a good cross section of the computer field and to obtain them from all sections of the United States.

Any suggestions from present Committee members as to prospective candidates for this Committee will be welcomed.

Since a quarum of the members were present, a Chairman was named. The Chairman is Earl W. Burdette, Carbide & Carbon Chemical Co., Oak Ridge National Laboratory, P. O. Box P, Oak Ridge, Tenn.

The following members were present at this organizational meeting: Richard Wehrle, S. Kaufman, Juergen Roedel, Norman F. Marti (representing Preston Simms) and Earl W. Burdette.

National Committees & Chairmen

Society Structure & Planning—Nelson Gildersleeve
Nominating—Ralph D. Webb
Constitution, Rules and Procedures—R. L. Galley
Instrument Industry—Charles L. Saunders
Finance—G. R. Feeley
Meetings & Exhibits—E. J. Grace, Jr.
Publications—C. W. Covey
Sections & Memberships—M. S. Jacobs
Employment—P. V. Jones, Jr.
Intersociety Relations—J. C. Peters
Public Relations—Douglas M. Considine
Government Relations—Ralph L. Goetzenberger
Educational—Prof. Robert J. Jeffries
Historical—L. M. Susany
Technical Program—E. G. Eskin
***Research and Development**—Chairman to be selected
Instrument Operation and Maintenance—J. Johnston, Jr.
Testing Instrumentation—D. C. Little
Analysis Instrumentation—Dr. Axel H. Peterson
Instrumentation for Inspection and Gaging—Thomas W. Marshall, Jr.
Instrumentation for Production Processes—C. A. Hansen, Jr.
Instrumentation for Transportation—John J. McDonald
Medical Instrumentation—Dr. H. J. Morowitz
Meteorological Instrumentation—Christos Harmantas
Radiation Instrumentation—Richard W. Johnston
Geophysical Instrumentation—S. Kaufman
Physical Properties Measurement—Prof. H. C. Roberts
Aeronautic Instrumentation—Robert Tozier
Data Handling—E. W. Burdette—R. P. Wehrle
Recommended Practices—A. V. Novak

Chicago Kick-Off Luncheon Success

The Kick-Off luncheon for the Eighth National Instrument Conference and Exhibit arranged by the Chicago Section Host Committee for Chicago professional, technical and businessmen was a success.

Dr. John T. Retalliata, president of Illinois Institute of Technology delivered an address on "The Value of Instrumentation to Industry".

Tentative Technical Program
National Instrument Conference
Morrison and Sherman Hotels
September 21-25, 1953

Monday, September 21
9:30 A.M.

ISA Session on Instrumentation for Production Processes.
Grand Ballroom
Chairman, J. Ward Percy (U.S. Steel Co., Kearny, N. J.) Recorder, Robert N. Wilson (Kelly Springfield Tire Co., Cumberland, Md.)

"Instrumentation for Statistical Quality Control" by William Hecox and Roger L. Merrill (Battelle Memorial Institute, Columbus, Ohio) Paper No. 53-1-1

"Segmental Recorders," by L. P. Haner and C. G. Dell (E. I. du Pont de Nemours & Co., Wilmington, Delaware) Paper No. 53-1-2

"Specific Gravity Measurements in Starches," by Glenn A. Pettit (Union Starch & Refining Co., Granite City, Ill.) Paper No. 53-1-3

* * *

ISA Session on Testing Instrumentation.
Embassy Room
Chairman, C. E. Fry (Westinghouse Electric Corp., E. Pittsburgh, Pa.) Recorder, G. N. Krouse (Krouse Testing Machine Co., Columbus, Ohio)

"Industrial Instrument Calibration" by Charles R. Sipe and C. H. Imschweiler (Westinghouse Electric Corp. East Pittsburgh, Pa.) Paper No. 53-2-1

"Calibration of Electrical Instruments in an Educational Laboratory" by H. N. Hayward (University of Illinois, Urbana, Illinois) Paper No. 53-2-2

"The Testing of Electrical Instruments" by Francis L. Hermach (National Bureau of Standards, Washington, D.C.) Paper No. 53-2-3

"The Manufacturers Viewpoint on Instrument Calibration" by Henry Berring (Weston Instrument Corporation, Newark, N. J.) Paper No. 53-2-4

Monday, September 21
2:00 P.M.

ISA Session Instrument Operation and Maintenance.
Venetian Room
Chairman, A. K. Joecks (Consolidated Edison Co. of New York, N. Y.) Recorder, L. C. Laird (Corn Products Refining Co., Argo, Ill.)

"Steam Turbine Supervisory Instruments" by J. C. Spahr (Westinghouse Electric Co., Philadelphia, Pa.) Paper No. 53-3-1

"Steam Turbine Supervisory Instruments" by R. L. Jackson (General Electric Co., Schenectady, N. Y.) and E. Uses (General Electric Co., Lynn, Mass.) Paper No. 53-3-2

* * *

ISA Session on Analysis Instrumentation.
Parlors F-G
Chairman, T. C. Wherry (Phillips Petroleum Co., Bartlesville, Okla.) Recorder, (To be named)

"General Problems in Sampling for Analysis Instrumentation" by S. P. Spracklen (Carbide and Carbon Chemicals Co., Charleston, W. Va.) Paper No. 53-4-1

"Sample Handling Considerations with Continuous Infrared Analyzers" by Glenn Smith (Process Controls Division of Baird Associates, Cambridge, Mass.) Paper No. 53-4-2

"Sampling Systems for Plant Analyzers" by B. W. Thomas and R. L. Martin (Humble Oil and Refining Com-Martin (Humble Oil and Refining Company, Baytown, Texas) Paper No. 53-4-3

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ISA Session on Physical Properties Measurement.
Parlors B-C-D
Chairman, Howard C. Roberts (University of Illinois, Urbana, Ill.) Recorder, R. Ferguson (Association of American Railroads, Chicago, Ill.)

"A Modified Double Bridge for Dielectric Measurement" by Robert D. McClain and R. E. Wendt, Jr. (Westinghouse Electric Corp., East Pittsburgh, Pa.) Paper No. 53-5-1

"Precision Conductivity Bridge: Design and Construction Details" by G. R. Peirce and Howard C. Roberts (University of Illinois, Urbana, Illinois) Paper No. 53-5-2

"Precision Conductivity Bridge: Performance Details" by R. L. Fischer and C. S. Vestling (University of Illinois, Urbana, Ill.) Paper No. 53-5-3

"Mechanical Dissociation of Fluids and Dielectric Constant Measurement" by R. E. Roberts (du Pont Co., Baltimore, Md.) and Sundaram Seshu (University of Illinois, Urbana, Ill.) Paper No. 53-5-4

Tuesday, September 22
9:30 A.M.

ISA Session on Instrumentation for Production Processes.
Grand Ballroom
Chairman, F. H. Trapnell (E. I. du Pont de Nemours & Co., Wilmington, Delaware) Recorder, Earl Seagrave Celanese Corp. of America, Cumberland, Md.)

"Dynamic Analysis of a Heat Exchanger System" by George W. McKnight and Charles W. Worley (Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.) Paper No. 53-6-1

"Pneumatic Multiplying for Process Control" by W. R. Bailey (Brown Instruments Division, Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.) Paper No. 53-6-2

"Determination of Minimum Capacities for Control Applications" by F. W. Velguth and R. C. Anderson (Corn Products Refining Co., Chicago, Ill.) Paper No. 53-6-3

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ISA Session on Testing Instrumentation.
Embassy Room
Chairman, H. F. Rondeau (American Meter Co., Erie, Pa.) Recorder, S. A. Hluchan (Oak Ridge National Laboratory, Oak Ridge, Tenn.)

"Practical Considerations in Designing AC and DC Bridges" by G. R. Peirce (University of Illinois, Urbana, Illinois) Paper No. 53-7-1

"History of SR-4 Strain Gage" by Frank G. Tatnall (Baldwin-Lima-Hamilton Co., Philadelphia, Pa.) No Paper

"High-Stability Circuitry for Resistance Strain Gages" by Howard C. Roberts (University of Illinois, Urbana, Illinois) Paper No. 53-7-2

"The Measurement of Surface Strains on Airplane Plexiglas" by B. Surratt and R. B. Wentworth (Boeing Airplane Co., Wichita, Kansas) Paper No. 53-7-3

"The Determination of Dynamic Strain" by C. M. Hathaway (Hathaway Instrument Co., Denver, Colorado) Paper No. 53-7-4

* * *

ISA Session on Aeronautical Instrumentation.
Venetian Room
Chairman, W. W. Johnston, Jr. (ARO, Inc., Tullahoma, Tenn.) Recorder, (To be named)

"Mathematical and Experimental Techniques for the Determination of the Dynamic Performance of Pressure Gages" by C. Hylkema and R. Bowersox (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif.) Paper No. 53-8-1

"A Remote Controlled Mechanical Arm" by E. R. Van Krevelen (Mechanical Division, General Mills, Inc., Minneapolis, Minn.) Paper No. 53-8-2

* * *

ASME Instruments and Regulators Division Session I Symposium on Production Weighing and Control
Cotillion Room
Chairman, J. E. Voytilla (E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.) Vice Chairman, L. E. Smith (The Bristol Company, Waterbury, Conn.)

"A Buoyancy Type Liquid Metering Unit" by Wilder C. Stickney (Chemical Plants Division, Blaw-Knox Co., Pittsburgh, Pa.)

"High Speed Weighing" by N. G. Maloney (E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.)

"Continuous Weighing Meters and Feeders" by J. O. Kirwan and L. E. Demler (Wallace & Tiernan Company, Inc., Newark, N. J.)

"Continuous Gravimetric Proportioning Systems" by R. P. Lowe (Proportioneers, Inc., Providence, R. I.)

* * *

IRE Session
Rooms 329-30-31
Chairman, Kipling Adams (General Radio, Chicago, Ill.) Recorder, (To be named)

"A Miniature Piezoelectric Microphone" by John Medill (Sure Brothers, Chicago, Ill.)

"A Transformer Bridge for Three Terminal Capacitors" by L. W. Matsch and J. L. Radnick (Armour Research Foundation, Chicago, Ill.)

"Measurement of Field Strengths and RF Noise" by William Schlesinger (Electronic Development Laboratories, Inc., Chicago, Illinois)

Tuesday, September 22
2:00 P.M.

ISA Sessions on Instrumentation for Transportation and Geophysical Instrumentation.
Venetian Room
Chairman, J. J. McDonald (Consolidated Engineering Corp., Chicago Ill.) Recorder, Wm. Kneen (Pullman Standard Car Mfg. Co., Hammond, Ind.)

"The V. G. A. Flight Recorder" by G. O. Haglund and James J. Ryan

(General Mills, Inc., Minneapolis, Minn.) Paper No. 53-9-1
Paper No. 53-9-2 (To come)
"Applications of Magnetic Recording to Seismic Exploration" by M. J. Stolaroff (Ampex Electric Corp., Redwood City, Calif.) Paper No. 53-9-3

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ASME Instruments and Regulators Division Session II Symposium on Production Weighing and Control.
Cotillion Room
Chairman, C. R. Davis (Davis Automatic Controls Ltd., Toronto, Canada) Vice Chairman, Carl Sanders (E. I. du Pont de Nemours & Company, Wilmington, Del.)
"Processing and Proportioning Materials by Weight" by Enrico Klein (Richardson Scale Co., Clifton, N. J.)
"Batch Weighing for Process Control" by Alfred H. McKinney (E. I. du Pont de Nemours & Co., Wilmington, Del.)
"Solids Flow and Level Measurement by Continuous Weighing" by Robert H. Berg (Process Control Services Co., Elmhurst, Illinois)
"A Proportioning Batch Meter" by L. E. Mylting (The Allen-Sherman-Hoff Co., Wynnewood, Pa.)

Wednesday, September 23 9:30 A.M.

ISA Session on Instrumentation for Production Processes
Grand Ballroom
Chairman, E. H. C. Brown (Industrial Engineering Corp., Louisville, Ky.) Recorder, L. D. Cipriano (Monsanto Chemical Co., St. Louis, Mo.)
"Human Engineering in Power Plant Instrumentation" by John G. Fleming (The Bristol Co., Waterbury, Conn.) Paper No. 53-10-1
"Instrumentation of Steam Power Plants" by Herman H. Johnson (Consolidated Edison Co. of New York, Inc., New York, N. Y.) Paper No. 53-10-2
"A Wide-Range Flow Controller" by A. A. Kalinske (Infilco Inc., Tucson, Arizona) Paper No. 53-10-3

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ISA Session on Testing Instrumentation.
Embassy Room
Chairman, S. A. Hluchan (Oak Ridge National Laboratory, Oak Ridge, Tenn.) Recorder, C. E. Fry (Westinghouse Electric Corp., E. Pittsburgh, Pa.)
"Simultaneous Single Channel Recording of the Displacement of Two Objects" by R. C. Geldmacher (Purdue University, West Lafayette, Indiana) Paper No. 53-11-1
"A Calibrator for Vibration Pick-Ups" by Martin Davidson and Wilfred A. Yates (National Bureau of Standards, Washington, D. C.) Paper No. 53-11-2
"Calibration of Accelerometers by Impact Techniques" by R. W. Conrad and Irwin Vigness (Naval Research Laboratory, Washington, D. C.) Paper No. 53-11-3

* * *

ISA Session on Instrumentation for Inspection and Gaging.
Parlors F-G
Chairman, Francis E. Penney (Alpha Engineering & Machine Works, Chicago, Ill.) Recorder, Clarence H. Brauer (International Harvester Co., Chicago, Ill.)
"Standard Calibration Methods of Measuring Instruments" by John A. Harrington, DoALL Company, Des Plaines, Ill.) Paper No. 53-12-1
"Ultrasonic Inspection Now More Versatile With Automatic Scanning and Recording" by W. I. Bendz (Sperry Products, Inc., Danbury, Conn.) Paper No. 53-12-2
"Versatility of the Toolmakers' Microscope for Inspection and Gaging" by Paul F. Meyn (Gaertner Scientific Corporation, Chicago, Ill.) Paper No. 53-12-3

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ISA Session on Instrumentation for Transportation
Venetian Room
Chairman, J. J. McDonald (Consolidated Engineering Corp., Chicago, Ill.) Recorder, Wm. Kneen (Pullman Standard Car Mfg. Co., Hammond, Ind.)
"Studies of Vibrations in Freight Cars" by L. Leland Olson (Association of American Railroads, Chicago, Ill.) Paper No.
"Automatic Transmission Instrumentation" by Carl R. Canfield (Borg-Warner Research, Bellwood, Ill.) and John Polomski (Borg-Warner, Detroit, Mich.) Paper No. 53-13-1
"Angular Position Indication by a Light Weight Variable Reluctance Pick-up" by Jerry Roedel (Pullman Standard Car Mfg. Co., Hammond, Indiana) Paper No. 53-13-2
"Instrumentation for Experimental Stress Analysis of Railroad Equipment" by Wilfred A. Berger (Pullman Standard Car Mfg. Co., Res. Dept., Hammond, Indiana) Paper No. 53-13-3

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ASME Instruments and Regulators Division Session III Symposium on Production Weighing and Control.
Cotillion Room
Chairman, Professor G. V. Edmonson (University of Michigan, Ann Arbor, Mich.) Vice Chairman, J. R. Keim (Brown Instrument Div., Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.)
"Electronic Weight Determination as a Tool for Control and Measurement Procedures" by Verne C. Kennedy (Streeter-Amet Co., Chicago, Ill.)
"Electric Weighing. Applications in Steel Mill Processes" by R. J. Carleton, Jr. (Gilmore Industries, Inc., Cleveland, O.)
"Strain Cell Weighing" by Lee Barnette (Hercules Powder Co., Wilmington, Del.)
"Remote Weight Measurement by Means of Hydraulic Load Cells with Electrical Transmitters" by Joseph J. Hicks (The Chemstrand Corp., Pensacola, Fla.)

Wednesday, September 23 2:00 P.M.

AIEE Session I on Instruments and Measurements
Venetian Room
Chairman, A. J. Hornfeck (Bailey Meter Co., Cleveland, O.) Recorder, (To be named)
"A Chemo-Electrical Method for Controlling Furnace Atmosphere" by W. L. Besselman (Leeds and Northrup Co., Philadelphia, Pa.)
"A Combustion Guide and Safeguard of the Gas Analyzer Type" by J. E. McEvoy (Bailey Meter Co., Cleveland, O.)
"An Automatic Transfer Function Measuring and Recording System" by R. J. Ehret, E. F. Hochschild, J. M. Embree, and E. C. Grogan (Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Philadelphia, Pa.)
"New Techniques in Data Reduction" by B. S. Benson (The Benson-Lehner Corp., West Los Angeles, Calif.)

* * *

ASME Instruments and Regulators Division Session IV Symposium on Production Weighing and Control
Cotillion Room
Chairman, R. E. Clarridge (Taylor Instrument Companies, Rochester, N. Y.) Vice Chairman, J. S. Cobb, Jr. (E. I. du Pont de Nemours & Co., Inc., Martinsville, Va.)
"Characteristics of Components in Pneumatic Weighing Systems" by John W. Milroy (CDC Control Services, Inc., Hatboro, Pa.)
"Bourdon Tubes and Bourdon Tube Gages" by L. M. Van Der Pyl
Panel Discussion "Production Weighing and Control."

Thursday, September 24 9:30 A.M.

ISA Session on Instrumentation for Production Processes
Grand Ballroom
Chairman, C. A. Mossman (Oak Ridge National Laboratory, Carbide & Carbon Chemicals Co., Oak Ridge, Tenn.) Recorder, J. Upson (Union Bag and Paper Co., Savannah, Ga.)
"Liquid Metal Magnetic Flowmeters" by W. Curtis Gray and Eugene R. Astley (General Electric Co., Schenectady, N. Y.) Paper No. 53-14-1
"Instrumentation for Radiochemical Processing-Recovery of Iodine ^{131}" by Justus N. Baird, Jr. (Oak Ridge National Laboratory, Oak Ridge, Tenn.) Paper No. 53-14-2
"A Neutron Thermopile" by J. T. DeLorenzo (Oak Ridge National Laboratory, Oak Ridge, Tenn.) and T. R. Herold (E. I. du Pont de Nemours & Co., Inc., Savannah River, Ga.) Paper No. 53-14-3

* * *

ISA Session on Testing Instrumentation.
Embassy Room
Chairman, R. P. Wehrle (International Harvester Co., Chicago, Ill.) Recorder, H. F. Rondeau (American Meter Co., Erie, Pa.)
"An Introduction to Analog Computers" by Jerry Roedel (Pullman Standard Car Mfg. Co., Hammond, Indiana) Paper No. 53-15-1
"Computers and Simulations Techniques in the Instrumentation Industry" by Chalmer E. Jones (Berkeley Scientific Div. of Beckman Instruments, Inc., Richmond, Calif.) Paper No. 53-15-2
"Functional Design Considerations for an Inexpensive Analog Computer" by Bernard H. List, R. E. Martin and William Hecox (Battelle Memorial Institute, Columbus, Ohio) Paper No. 53-15-3
"Building Block Analog Digital Data Processing Systems" by George S. Slocome and Duncan N. MacDonald (Consolidated Engineering Corp., Pasadena, Calif.) Paper No. 53-15-4

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ISA Session on Medical Instrumentation
Parlors F-G
Chairman, Dr. Alfred Henley (American Instrument Co., Silver Springs, Md.) Recorder, (To be named)

"Techniques of Micro Analysis" by Arnold Lazarow (Western Reserve University, Cleveland, Ohio) Paper No. 53-16-1

"Continuous Recording Oximeters with Clinical Applications" by M. G. Heller, John F. Perkins, Jr. W. E. Adams and R. A. Weaver (University of Chicago, Chicago, Ill.) Paper No. 53-16-2

"Instrumentation in Radiomicrography: 1. Camera Design" by J. Edward C. Askin and J. Burton Hayes (University of Illinois, Chicago, Ill.) Paper No. 53-16-3

"An Automatic Recording Extrapolation Ionization Chamber for the Study of Ionization Distribution in Very Thin Absorbers from 23 meV Betatron to the Grenz-Ray Region" by Walter Moos, J. E. C. Askin, J. Wesley Beattie and W. J. Henderson (University of Illinois, Chicago, Ill.) Paper No. 53-16-4

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AIEE Session II Electronic Instruments
Rooms 329-30-31
Chairman, W. H. Wickham (Commonwealth Edison Co., Chicago, Ill.) Recorder, (To be named)

"Preliminary Development of a Magnetor Current Standard" by E. P. Felch (Bell Telephone Laboratories, Inc., Murray Hill, N. J.) and J. L. Potter (Rutgers University, New Brunswick, N. J.)

"An Electronic Flow Meter" by H. P. Kalmus (National Bureau of Standards, Washington, D. C.)

"A-C Null-Type Recorder with Balancing Amplifier which Provides Damping and Suppresses the Quadrature Component" by A. J. Williams, Jr., and J. F. Payne, Jr. (Leeds and Northrup Co., Philadelphia.)

Thursday, September 24
2:00 P.M.

ISA Session on Testing Instrumentation
Grand Ballroom
Chairman, D. C. Little (Army Medical Research Laboratory, Ft. Knox, Ky.) Recorder, O. L. Linebrink (Battelle Memorial Laboratory, Columbus, Ohio)

"Instrumentation in Research and Development—The Fundamentals" (A Panel Discussion) Introduction—Everett S. Lee (General Electric Co., Schenectady, N. Y.)

Panel Members—C. S. Draper (Massachusetts Institute of Technology, Cambridge, Mass.), E. P. Felch (Bell Laboratories, Murray Hill, N. J.), W. G. Brombacher (National Bureau of Standards, Washington, D. C.), C. F. Lucks (Battelle Memorial Inst., Columbus, Ohio) and Taylor C. Fletcher (Beckman Instruments, Inc., Pasadena, Calif.)

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ISA Session on Medical Instrumentation
Parlors F-G
Chairman, Dr. Raymond Jonnard (Paterson General Hospital, Paterson, N. J.) Recorder, (To be named)

"Simultaneous Comparison of Variable Brain Patterns" by Chester W. Darrow and G. Peter Arnott (Institute for Juvenile Research, Chicago, Ill.) Paper 53-17-1

"The Electromagnetic Flowmeter in Industry and Biology" by Gerald H. Giczewski (Bowser, Inc., Fort Wayne, Indiana) Paper No. 53-17-2

"Some principles of Accurate Instrumentation in Vectorcardiography" by Dr. Daniel A. Brody (University of Tennessee, Memphis, Tenn.) Paper No. 53-17-3

"An Electronic Analog Computer to Determine Areas Under Electrophoresis Diagram Curves" by Daniel M. Ekstein (Matthew Laboratories, Yonkers, N. Y.) Paper No. 53-17-4

"An Apparatus for the Quantitation of Biological and Other Data by Photoelectric Measurement of Areas" by Julius Sendroy, Jr., and L. O. Cecchini (National Naval Medical Center, Bethesda, Md.) Paper No. 53-17-5

Friday, September 25
9:30 A.M.

ISA Session on Instrumentation for Production Processes
Grand Ballroom
Chairman, T. H. Pierson (Corn Products Refining Co., Argo, Ill) Recorder, C. A. Hansen (General Electric Co., Schenectady, N. Y.)

"Evaporator Control in the Food Industry" by John E. Barber (Taylor Instrument Cos., Rochester, N. Y.) Paper No. 53-18-1

"Instrumentation for Continuous Metal Casting" by John V. Metzger and Joseph F. Hornor (Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.) Paper No. 53-18-2

"A Catalytic Combustion Hydrogen Gas Analyzer" by D. S. Toomb, Jr. (Oak Ridge National Laboratory, Oak Ridge, Tenn.) Paper No. 53-18-3

"Continuous Carbon Monoxide Analyzer" by Marvin D. Weiss, Morris J. Schwartz and Benjamin J. Cooper (Taller & Cooper, Inc., Brooklyn, N. Y.) and Roger Gilmont (The Emil Greiner Co., New York, N. Y.) Paper No. 53-18-4

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ISA Session on Medical Instrumentation
Parlors F-G
Chairman, Dr. B. P. McKay (University of Tennessee, Memphis, Tenn.) Recorder, (To be named)

"Precision and Cost in Instrumentation" by Donald E. Williamson (Codesign Corporation, Winchester, Mass.) Paper No. 53-19-1

"Synthetic Organ Mechanisms—A Challenge to the Instrument Designer" by Arthur E. MacNeill, M. D. (Chronic Disease Research Institute, Buffalo, N. Y.) Paper No. 53-19-2

"Prospects in Biological-Medical Instrumentation: A Review of Unappraised Potentialities" by Raymond Jonnard, Dr. Sc. (Patterson General Hospital, Paterson, N. J.) Paper No. 53-19-3

"Measurement in Biology" by Harold J. Morowitz (National Bureau of Standards, Washington, D. C.) Paper No. 53-19-4

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ISA Session on Process Control Instrumentation
Embassy Room
Chairman, Neil M. Blair (Pannelit, Inc., Chicago, Ill.)
Recorder, To be named

"The Application of Electronic Process Control to Oil Refineries" by W. T. Marchment (Evershed & Vignoles, Ltd., Acton Lane Works, Chiswick, London, W. 4) Paper No. 53-20-1

"Study of Process Control by Phase Angle Loci Method" by Yaohan Chu (Brown Instruments Division, Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.) Paper No. 53-20-2

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ISA Session on Data Handling
Venetian Room
Chairman, E. W. Burdette (Oak Ridge National Laboratory, Carbide & Carbon Chemical Co., Oak Ridge, Tenn.) Recorder, (To be named)

A SYMPOSIUM

"Analogue to Digital Data oCnversion Techniques". Moderator—E. W. Burdette (Oak Ridge National Laboratory, Carbide & Carbon Chemical Co., Oak Ridge, Tenn.) Paper No. 53-21-1

Advance Registration Form For
Fifth Pre-Conference Instrument Maintenance Clinic

INSTRUMENT SOCIETY OF AMERICA
1953 Pre-Conference
Instrument Maintenance Clinic

Application for ADVANCE REGISTRATION

Morrison Hotel, Chicago, Illinois, September 18, 19, 20, 1953

Please Print the information below and return this form to P. V. Jones, Manager ISA, 1319 Allegheny Ave., Pittsburgh 33, Pa.

NAME ..... Title or Position .....

ADDRESS .....

COMPANY..... Products.....

COMPANY ADDRESS .....

Member of ISA?..... ASME?..... AIEE?..... IRE?..... SAMA?..... None?.....

I am willing to act as group leader in taking attendance, making announcements, etc., for a group of 20 men.....

Signature .....Date.....

NOTE: Registration FREE to members of ISA and Cooperating Societies; Registration *Fee to all others is* $3.00 which must accompany application.

ISA's EIGHTH ANNUAL EXHIBIT	DESCRIPTIVE LIST of EXHIBITS	SHERMAN HOTEL CHICAGO Sept. 21-25, 1953

Alina Corporation
New York 13, New York 287
Exhibiting: New Products—Pneumatic chart drive, 30 min. running reserve, self-starting, fully automatic, dust- and corrosion-protected. **Regular Products**—Mechanical chart drives for cylindrical, circular and strip charts, chart drive designed to SAMA specifications, pressure gage movements, anemometer movements, time switches, interval timers; Parts; Sub-assemblies. **Services**—Engineering assistance in resolving timing problems.

Alleghany Instrument Company
Cumberland, Maryland 11, 12
Exhibiting: New Products—D-c amplifier, gain 3000, employed to drive cathode-ray oscillographs and tape recorders; D-c. amplifier designed to drive galvanometer oscillographs; High-gain d-c. amplifier designed for pen motors. **Regular Products**—Model 204 dynamic temperature and strain recorder. **Services**—Engineering and manufacturing services for new instruments, both design and research.

American Institute of Electrical Engineers
New York 18, New York 144-B
Exhibiting: Publications of the Institute.

American Instrument Company
Silver Spring, Maryland 135
Exhibiting: New Products—Temperature and humidity controlled "Climate-Lab"; Small Sub-Zero Cabinet for instrument testing. **Regular Products**—Electric hygrometer; "Magne-Gage"; Refrigerated constant-temperature bath; Cutting-off machine; High-pressure pump, 30,000 psi.; Relays, Regulators; Heaters.

American Meter Company
Philadelphia 2, Pa. 167, 168
Exhibiting: Regular Products—"A-88" orifice meter, Dri-Flo meter, orifice disks, gage line connections, needle valves, transmitters and receivers, straightening vanes, flanges, meter runs.

American Society of Mechanical Engineers
New York 18, New York 41
Exhibiting: A.S.M.E. publications and information concerning the American Society of Mechanical Engineers.

Ampex Electric Corporation
Redwood City, California 256
Exhibiting: New Products—Model 306 magnetic tape recorder, records signals in range of 0 to 5000 cps., recorded signal virtually free of error due to mag-tape flaws. **Regular Products**—Multi-Channel magnetic recorders for recording laboratory and industrial information in ranges of 0 to 5000 cps. and 200 to 100,000 cps. and pulse widths.

Anders Lykens Corporation
Lykens, Pa. 158
Exhibiting: New Products—Model F.A.W. Type E fully automatic dryers. **Regular Products**—Model FA Type E fully automatic dryer. **Services**—Engineering and design of complete compressed air, industrial gases, and liquid phase hydrocarbon drying systems.

Annin Company
Los Angeles 23, California 188, 189
Exhibiting: New Products—Model 2560 Domotor valves; Model 2520 cylinder valves; Figure 25 manual valves; Model 3560 Domotor valves; Model 3520 cylinder valves; Figure 35 manual valves; Model 5060 Wee Willie Domotor valves; Model 5020 Wee Willie cylinder valves; **Regular Products**—Model 1560 Domotor valves; Model 1520 cylinder valves; Figure 15 manual valves; Model 1542 Domotor-powered actuators; Model 1544 Domotor-powered actuators. **Services**—All valves designed for application in chemical and petrochemical industries.

Ashton Valve Company
Wrentham Massachusetts 215
Exhibiting: Regular Products—Nozzle type safety valve; Nozzle type relief valve; Indicating and recording pressure gage; Gage testing equipment.

Askania Regulator Company
Chicago 11, Illinois 23, 24
Exhibiting: New Products—Dyna-Jet system, electrohydraulic control for processes in which power consumption is a convenient index to some other variable. **Regular Products**—Edge position control; Jet pipe regulator.

Associated Research, Inc.
Chicago 18, Illinois 17
Exhibiting: New Products—Model 273 vacuum-tube voltmeter; Model 272 "Vibrotest"; New model "Vibroground"; Model 424 d.c. "Hypot." **Regular Products**—"Vibrotest," "Vibroground," "Hypot," Donut current transformers; shunts; phase sequence indicators; precision ohmmeters; Keeler Polygraph (lie detector). **Services**—Complete facilities for all electrical instrumentation.

Associated Valve and Engineering Company
Chicago 21, Illinois 78, 79
Exhibiting: New Products—All-Teflon hand and motorized valves (all wetted parts machined from Teflon bar stock); Valves machined for Koncentric fittings. **Regular Products**—Safety and relief valves, needle, globe, solenoid, solenoid air cylinder, electric motor, diaphragm valves, special design valves for high pressure and temperature and corrosive service. **Services**—Engineering and design of special valve application.

Atkomatic Valve Company
Indianapolis, Indiana 166
Exhibiting: New Products—Solenoid valves, cast iron and steel; Direct lift valves; Stainless steel valves. **Regular Products**—Electric solenoid valves.

Automatic Electric Sales Corporation
Chicago 7, Illinois 124
Exhibiting: New Products—"Series OCS" rotating cam-actuated relay or stepper suitable for replacing on-off latching-up relay or for providing special sequence programming on custom-engineered basis; Shock and vibration resistance. **Regular Products**—Telephone-type relays and stepping switches, open and hermetically sealed. Shok-Lok and regular lever keys; Push and turnkeys, dials, lamps, etc.; Precious metal contacting steppers for instrument circuits.

Automatic Switch Company
Orange, New Jersey 60, 61
Exhibiting: New Products—Mechanically held electrically-operated multi-contact relays for high shock service, for "memory" circuits, to permit preset control operations; 4-way poppet type "Super-Duty" solenoid valve, 4 and 5 port construction, pressures up to 250 psi., rated 500 cycles/min. continuous duty, 750 cycles/min. intermittent duty; Compact pilot-controlled valve for corrosive liquids and gases combines automatic remote pilot control with Saunders type diaphragm valve; Pressure-operated manually-reset valves in 2-, 3- or 4-way construction. **Regular Products**—Controls, electromagnetic; Switches, automatic transfer; Contactors and controllers, mechanically and magnetically held; Relays, general purpose and industrial control; Switches, remote control; Relays; Valves; Solenoids.

Automatic Temperature Control Company
Philadelphia 44, Pa. 25, 26, 27
Exhibiting: New Products—Process control instruments; tank weighing system (electrical transmission); pneumatic program controllers; front panel mounted "Vernier-set" timers; electric and electronic counters; "Atcotran" electrical system for measurement and control of pressure, vacuum, flow, etc.; "Duo-Set" timer, dial repeat cycle type. **Regular Products**—Motorized valves; Electronic relays; Input controllers; Impulse counters; Electronic contactors; Vernier set timers; Cam timers; Electronic timers; Delay timers; Valves butterfly and V-port; atcometer.

Bailey Meter Company
Cleveland 10, Ohio 90, 91, 92
Exhibiting: New Products—Oxygen and Combustibles Analyzer, continuously records on two-pen electronic recorder and/or controller; Pneumatic Transmitters for flow, pressure, draft, temperature, level, etc.; MINI-LINE multi-point indicators receive signals from pneumatic transmitters, may also indicate pressure and temperature directly, bring related factors together in a "pointer pattern"; MINI-LINE Ratio Relay amplifies, proportions, reverses, subtracts or totalizes pneumatic signals as desired, affords any combination or all of Proportional, Reset, Rate and Floating; MINI-LINE Selector Valve, miniature hand-automatic selector includes four indications of air pressures, hand-auto transfer switch, set point or bias control adjustment, and knob for remote manual control; Remote Manual Loader, provides manual control of valves and drives from a distant point, includes single or duplex indications of pneumatic signals on single scale. **Regular Products**—Control drives; Positioning relay; Resistance thermometer, Armortube cable; Boiler meter. **Services:** Application engineering for measurement and control; service engineering; Design engineering for control panels.

Baldwin-Lima-Hamilton Corporation
Philadelphia 42, Pa. 124-A, 124-B

Barber-Colman Company
Rockford, Illinois 48, 49
Exhibiting: New Products—Multipoint Capacilog, continuous recording of up to six variables on single strip chart; Single-point Capacilog; Pneumatic Capacilog strip-chart recorder with air-operated control system; Capaciline, for straight line control, available as separate instrument for use with standard on-off type instruments or integrally mounted in Wheelco recorders and controllers. **Regular Products**—Indicators, controllers, combustion safe guards.

Barton Instrument Company
Los Angeles 22, California 113, 114
Exhibiting: New Products—Flow transmitter, pneumatic, rupture-proof bellows-actuated differential pressure transmitter with mechanically linked indicating pointer. **Regular Products**—Differential pressure indicators, switches and recorders.

Arnold O. Beckman Inc.
South Pasadena, California 302
Exhibiting: New Products—Combustion analysis system for steam generators, open-hearth furnaces, glass tanks, rotary kilns, and catalyst regenerators; Dissolved Oxygen Analyzer; Industrial Recording Oxygen Analyzer; Dosimeter Charger. **Regular Products**—Combustion analyzer, High- Purity oxygen analyzer; Trace analyzer; Portable analyzer; Dosimeters.

Beckman Instruments, Inc.
South Pasadena, California
.....198, 199, 200
Exhibiting: Regular Products—Representative instruments of Beckman Division, Helipot Division, and Berkeley Division, including industrial and laboratory pH meters and electrodes, flow colorimeter, micro-microammeter, Aquameter, recording spectrophotometer; precision voltage-dividing resistors, multiple-turns-indicating Duodials; Events-Per-Unit-Time Meters, frequency meters, time interval meters, applications of decimal counting units.

Bendix Aviation Corporation
Cincinnati Division
Cincinnati 2, Ohio 70C, 70D
Exhibiting: Regular Products—Bendix Ultra-Viscoson Equipment: standard unit with standard probe, high sensitivity unit, automatic temperature control system, allied recorder system.

Benson-Lehner Corporation
Los Angeles 64, California 301
Exhibiting: New Products—"Oscar Model E" oscillograph trace reader, 35 mm. to 12 in. wide film or paper, one operation applies non-linear calibration, scales, zero corrections, logs, squares, interpolating time, instantaneous records as tabulations, plots, or punched cards; Dactylograph, provides automatic plotting from information fed into keyboard or directly to servo-system from d-c. voltage source (OSCARO or IBM Summary Punch). **Services**—Data reduction of oscillograph or ballistic film or paper records.

James G. Biddle Company
Philadelphia 7, Pennsylvania 7
Exhibiting: New Products—Motor rotation test set, to determine rotation of idle motor **before** it has been connected for operation, to determine polarity of power and instrument transformers; Model 4 impulse cable fault locator and d-c proof tester, maximum output of 15 kv d-c and discharge capacitance of 2 m u f. **Regular Products**—Megger electrical resistance measuring instruments, Jagabi speed measuring instruments, Frahm resonant reed tachometers, Frahm frequency meters (resonant reed), Frahm resonant reed relay, Jagabi tubular slide wire rheostats & carbon piles.

J. Bishop & Co. Platinum Works
Malvern, Pa. 236, 237
Exhibiting: Regular Products—Small diameter stainless steel tubing; Fabricated stainless steel tubular specialties; Platinum for technical and industrial uses. **Services**—Engineering, design, research for tubing, specialties, precious metals.

Black, Sivalls and Bryson, Inc.
Kansas City 26, Missouri
.....148, 149, 150
Exhibiting: New Products—High-pressure linkage for lever valves; Type Y continuously-connected side handwheel for diaphragm control valves, can be set to operate manually. **Regular Products**—Pressure-balanced diaphragm control valve with reverse-action relay and valve positioner; Diaphragm control valve with bellows-sealed stem. Expanded outlet diaphragm control valve; RMC three-way control valve; Three-way diaphragm control valve; Simplex pressure-balance diaphragm regulator; Supply-medium reducing regulator; Fixed-ratio relay regulator; Reverse-action relay; Stuffing box assemblies; Inner valves.

Boeing Airplane Company
Seattle 14, Washington 42
Exhibiting: Regular Products—Model 7000-A electronic analog computer and accessory equipment.

Bourns Laboratories
Riverside, California 283
Exhibiting: New Products—Miniature gage pressure pickup with 0.4 percent resolution, not damaged by vibration, acceleration or nominal over-pressure. Subminiature wire-wound "TRIMpot"; Linear motion voltage-dividing wire-wound resistors in all travel lengths from 0.5 inch to 20 inches; Absolute pressure, differential pressure and accelerometer pickups redesigned for greater accuracy and ruggedness; Potentiometer Test Meter with push button control. **Regular Products**—Wire-wound voltage dividing resistors to measure linear motion, gage pressure, differential pressure, absolute pressure and acceleration, linear or non-linear output. Functional output VDRs to meet specific circuit calibration or computer formulae. **Services:** Design, development and production of miniaturized units to customers' specifications.

Bowser, Inc.
Fort Wayne, Indiana 157
Exhibiting: Regular Products—Bowser Fig. 460 Xacto meter; Sight flow indicating devices; Fig. 445 Rotoral meter; Fig. 836 cartridge filter.

Bridgeport Thermostat Division
Robertshaw-Fulton Controls Company
Bridgeport 1, Connecticut 162, 163
Exhibiting: Regular Products—Bellows; Bellows assemblies; Marotta valves.

The Bristol Company
Waterbury 20, Connecticut 95, 96, 97
Exhibiting: New Products—Pyrometer control panel, with 12-point Dynamaster potentiometer pyrometer recorder, individual direct-set adjustable control points for each temperature; Electronic Dynamaster XY Recorder; Electronic Dynamaster round-chart program controller; Functionally-unitized pneumatic transmitters, recording receivers, indicating receivers, controllers, Electrical transmission miniature instruments; Combination program controller and cycle-time controller; Metameter telemeter with time and frequency multiplexing equipment, 15 readings over single circuit with an in-a-plant carrier telemeter; Telemetering equipment for microwave, low-voltage carrier, UHF transmission; System of remote setting of pneumatic and electric control devices; Remote position system for air craft. **Regular Products**—Two-pen strip-chart electronic Dynamaster; High-speed strip chart, multirange Dynamaster potentiometer; Round-chart and strip chart Dynamaster controllers, electric and pneumatic; Metameter telemetering instruments.

Brookfield Engineering Laboratories, Inc.
Stoughton, Massachusetts 190
Exhibiting: New Products—Viscometran, for continuous automatic remote indicating, recording and/or controlling viscosity. **Regular Products**—Synchro-lectric viscometer, counter-rotating mixer, viscometer accessories.

Brooks Rotameter Company
Lansdale, Pennsylvania 107, 108
Exhibiting: New Products—Rotameter Flow Handbook; Flow-Mizer for handling non-corrosive liquids and gases; Mag-New-Matic pneumatic transmitter; Ar-Met armored rotameter for dangerous liquids and gases to 500 deg. F. and 1000 psi.; Flo-Gard electronic rotameter alarm; Trin-Vue sight flow indicators; Mitey-Mite lab kits featuring new type cross-hair Teflon float stop. **Regular Products**—Multi-range Sho-Rate lab kits; Hi pressure lab kits; Sho-Rate purge meters; Brooks-Mite purge meters and with differential regulators; Multi-tube Brooks-Mites; Screwed and flanged full-view safety shielded rotameters; Hi-pressure armored rotameters; Inductronic recording controller integrator; Hi-Accuracy 600-mm. full-view rotameters.

Brush Electronics Company
Cleveland 14, Ohio 186, 187
Exhibiting: New Products—"Surfindicator" measuring roughness down to one-millionth of an inch. **Regular Products**—Welding analyser, ac. and dc. amplifiers, Bruel and Kjaer instruments, oscillographs, hypersonic generator and transducer.

Buffalo Meter Company
Buffalo 14, New York 228
Exhibiting: Regular Products—Meters, liquid volumetric type, for water, oils, solvents, chemicals, syrups, etc.

Burgess Battery Company
Freeport, Illinois 31
Exhibiting: New Products—No. 210 heavy industrial flashlight battery giving 27 percent more service on Bureau of Standards Heavy Industrial Test; Miniature electronic B batteries 15, 22½ and 30 volts. **Regular Products**—All types of dry batteries. **Services**—Complete dry battery engineering service; special batteries designed for special applications.

Burling Instrument Company
South Orange, New Jersey 39
Exhibiting: New Products—Model B-2C temperature control, for sub-zero to 300 degrees F. with two independently set switches, waterproof cast aluminum cover, operating by differential expansion of solids. **Regular Products**—Temperature controls for electric and pneumatic operation; Self-operating temperature controlled valves.

Carboloy Department
General Electric Company
Detroit 32, Michigan 232, 233
Exhibiting: Regular Products—Carboloy permanent magnets, thermistors, Hevimet, cemented carbides. **Services**—Technical literature, field engineering.

Century Geophysical Corporation
Tulsa, Oklahoma 100
Exhibiting: New Products—Multi-channel recording oscillograph operable from either a.c. or d.c. **Regular Products**—Recording oscillograph; Carrier amplifier; Linear-integrate amplifier; Bridge balance unit.

Chemiquip Company
New York 12, New York 30
Exhibiting: Regular Products—Mercureceivers; Chemiquip Porous Metal Pressure Snubbers.

Commercial Research Laboratories, Inc.
Detroit 3, Michigan 153, 154
Exhibiting: New Products—Type 12 Cox Flowmeters, "Inner Wall" guide glass type with logarithmic scale. **Regular Products**—Flowmeters, flowmeter calibrating stands, fuel nozzle test stands, engine indicaters, carburetor test stand, magnetic thickness gages, electronic instruments.

Conoflow Corporation
Philadelphia 3, Pa. 104, 105, 106
Exhibiting: New Products—Conomotor Services L. B. Control Valves for throttling control service, with new Conomotor cylinder operator. **Regular Products**—Cono Airpak; Cono Model E B Current Controller; Cono Rotomotor; Conopurge assemblies and Cono panels.

Consolidated Engineering Corporation
Pasadena 15, Calif. 218, 219, 220, 221
Exhibiting: New Products—Type 5-119 Deluxe Recording Oscillograph with new Type 7-300 galvanometers; Type 23-109 automatic record developer; Type 4-311 pressure pickup; Model 21-610 process monitor mass spectrometer; High-speed d-c amplifier. **Regular Products**—100-channel SADIC; analog-to-digital converter; recording oscillographs; vibration pickups; pressure pickups; leak detector; Titrilog; micromanometer. **Services**—Mass spectrometer analytical laboratory services—complex mixtures, isotope assays; leak detector.

Continental Equipment Company
Corapolis, Pennsylvania 82, 83
Exhibiting: Regular Products—Butterfly control valves.

Cook Electric Company
Chicago 14, Illinois 257
Exhibiting: New Products—Brain Boxes, an incorporation of Diaplex relays, time delays, timed relays, pressure switches, fine instruments and external sensing elements into packaged control systems. Ice detection and icing rate instrumentation. **Regular Products**—Relays, pressure switches, spring life bellows. **Services**—Testing facilities.

R. W. Cramer Company
Centerbrook, Connecticut 197
Exhibiting: New Products—Type E T Time Totalizer with unique clutch mechanism insuring maximum accuracy. **Regular Products**—Synchronous timing motors; interval timers; reset timers; time delay relays; cycle timers; hermetically sealed military timers; running time meters; pulse timers; percentage timers; multi-contact timers; chart drive motors; duplex cycle timers; intervalometers.

Crawford Fitting Company
Cleveland 10, Ohio 54, 55
Exhibiting: New Products—Swagelok fitting for quick disconnect. **Regular Products**—Swagelok tube fittings.

Crosby Steam Gage and Valve Company
Wrentham, Massachusetts 215
Exhibiting: Regular Products—Nozzle type safety and relief valves, pressure gages, gage testing instruments, protected gages.

George W. Dahl, Inc.
Bristol, Rhode Island 290
Exhibiting: New Products—"Demi" packless valves and manifolds for vacuum or high pressure service, in Aluminum, Stainless Steel, Nickel, Monel, etc.; "Bantam" two way and three way hand operated and diaphragm special valves for panel or in line mounting; "Monofold" (three valve manifold) two isolating and

one bi-pass valve controlled with one T handle or diaphragm operation.

Daven Company
Newark 4, New Jersey 121
Exhibiting: New Products—170-A vacuum tube voltmeter, frequency response flat to 250,000 cps.; Miniature rotary switches, maximum of 24 positions in 1-3/8" diameter; Miniature attenuator, 20 step ladder or potentiometer network in 1-3/8" diameter. **Regular Products**—Attenuators, potentiometers, rheostats, rotary tap switches, precision wire wound resistors, decade resistance boxes, transmission measuring equipment, voltage dividers, vacuum tube voltmeters, video equipment. **Services**—Design, development and sub-contracting.

Davis Instruments
Newark 4, N. J. 69, 70
Exhibiting: New Products—Selective continuous indicating and recording analyzer developed for low-range application (parts per million). **Regular Products**—Portable and continuous gas analysis instruments. **Services**—Design and manufacture of gas analysis and process control instrumentation, utilizing catalytic combustion, electrical conductivity and thermal conductivity.

Deltavis Company, S.A.
Soleure, Switzerland 255
Exhibiting: Precision screw machine products.

De Zurik Shower Company
Sartell, Minnesota 56
Exhibiting: Regular Products—Easy-operating eccentric plug valves. **Services**—Recommendations on lever-operated and instrument-controlled valve problems.

Diamond Power Specialty Corporation
Lancaster, Ohio 296
Exhibiting: New Products—"Model 300-BV Utiliscope" TV camera; "Utiliscope" view finder employing small picture tube to facilitate camera orientation and adjustment. **Regular Products**—"Model 300-B Utiliscope" wired television, equipment.

Durant Manufacturing Company
Milwaukee 11, Wisconsin 297
Exhibiting: New Products—Model 5-SP-1-MF Electric Predetermined Counter, for any setting to 10,000; Degree Counter for navigation equipment, indicates tenths of minutes; Double Bank Shutter Counter; Tape Recorder Counter. **Regular Products**—Instrument indicating counters for application on computers, navigating instruments, radar equipment, office machinery, and machine tools. **Services**—Design and application of electrical and mechanical counters.

F. W. Dwyer Manufacturing Company
Chicago 12, Illinois 99
Exhibiting: New Products—Inclined vertical gage, molded plastic with logarithmic curved indicator, for volume applications. **Regular Products**—Manometers, Pitot tubes, inclined gages, CO_2 indicators, pressure switches, flowmeters, low-pressure Magnehelic gages, air filter gages.

Eagle Signal Corporation
Moline, Illinois 29
Exhibiting: Regular Products—Microflex timers, delay relays, process timers, Hagen synchronous motors, predetermining counters.

Eastman Kodak Company
Rochester 4, New York 248
Exhibiting: New Products—Linagraph 482 paper; Linagraph 480 paper, type 1272. **Regular Products**—Linagraph papers and films, Kodagraph reproduction materials, Kodak high-speed camera; Photographic materials for science and industry.

Edin Company
Worcester 8, Massachusetts 120
Exhibiting: Regular Products—High and low gain d.c. amplifier, models 8105 and 8106 respectively; 8122 a.c. amplifier; Ink-writing galvanometers; recorders and consolettes. **Services**—Association of these instruments into a complete recording consolette system.

Thomas A. Edison, Inc.
Instrument Division
West Orange, New Jersey 28
Exhibiting: New Products—Alarm system and monitor for protection against excessive temperature, pressure or flow, designed for four points or multiples of four. **Regular Products**—Sealed thermostats, time delay relays, resistance bulbs, sensitive d.c. relays.

Electric Auto-Lite Company
Toledo 1, Ohio 179, 180A
Exhibiting: Regular Products—Recording thermometers, recording vacuum gages, recording pressure gages, dial-indicating thermometers.

Electric Regulator Corporation
Norwalk, Connecticut 293
Exhibiting: New Products—High-temperature potentiometers; Inverter Controls; Altinator controls. **Regular Products**—"Regohm." **Services**—Design and development of regulators for electonic use as filament control, servomechanisms, computers, live load regulators, power supplies, etc.

Engineering Research Associates
Division of Remington Rand, Inc.
St. Paul W 4, Minnesota 299
Exhibiting: New Products—Scale Model of ERA 1103 general-purpose high-speed digital computer system. **Regulator Products**—Four-channel wide-range amplifier; High gain plug-in amplifier with replaceable tubes; Pulse transformers; Electromechanical counters; Magnetic storage drum. **Services**—ERA Computation Center at Arlington, Va.: programming time and computing time available from August.

Esterline-Angus Company
Indianapolis 6, Indiana 176
Exhibiting: New Products—Model D portable multi-range universal current transformer; Model D permanent magnet tachometer generator. **Regular Products**—Recording d-c. milliammeter; Contact-making wattmeter; Recording wattmeter; 20-pen operation recorder; Chart drives.

Falstrom Company
Passaic, New Jersey 214
Exhibiting: New Products—New designs of electronic housings in both steel and aluminum; Heli-arc welding on aluminum; Deep wing panels. **Regular Products**—Instrument panels (steel and aluminum), cubicles, control cabinets, consoles, enclosures (steel and aluminum), miscellaneous fabricated steel and aluminum assemblies. **Services**—Design assistance in construction of instrument and control panels.

Farris Engineering Corporation
Farris Stacon Corporation
Farris Flexible Valve Corporation
Farris Pickering Governor Company
Palisades Park, New York 18, 19, 20
Exhibiting: Farris Engrg. Corp.—Safety and relief valves incorporating FarriSeal and Balan-Seal bellows construction for corrosion and eliminating the effects of back pressure surges, Farris Flex. Valve Corp.—X V series valves for shut-off, throttling and control of acids, chemicals and other corrosive abrasive fluids. Farris Stacon Corp.—Series V line of self-operating temperature regulators for steam, liquid and gases. Farris Pickering Gov. Co.—Mechanical, Hydraulic and ball ranger governors.

Fenwal, Inc.
Ashland, Massachusetts 234, 235
Exhibiting: New Products—Miniature thermoswitch for precise temperature control or detection in instruments and precision mechanisms adjustable through temperature range of 0 F. to 200 F. **Regulator Products**—Thermoswitch, temperature control thermostats; Detect-A-Fire. **Services**—Temperature control engineers.

Fielden Instrument Division
Robertshaw-Fulton Controls Company
Philadelphia 33, Pa. 164, 165
Exhibiting: New Products—"A.C. Self Balancer" potentiometer recorder; Resistance bulb; Multipoint circular chart recorders with or without control. **Regular Products**—Tektor level controls; Telstor level indicator; Tektolog recorders; Proximity meters.

Fisher Governor Company
Marshalltown, Iowa 128, 129, 130
Exhibiting: New Products—Non-freezing regulator: Split "Z" type valve body; Self-contained pressure regulator; Solid cast percentage V-port valves; Soft seat "O" ring control and shut-off valves. **Regular Products**—Pressure regulators, liquid level controllers, back pressure regulators, air loaded topworks, valve positioners, liquid level remote receivers with proportional and reset action; strainers; filter regulators.

Flexonics Corporation
Maywood, Illinois 277
Exhibiting: Regular Products—Flexon bellows, C.M.H. flexible metal hose, Flexon expansion joints.

Foster Engineering Company
Union, New Jersey 119
Exhibiting: Regular Products—Flowtubes; Pressure regulators; Relief and back pressure valves; Cushion check valves; Fan engine regulators; Pump governors; Temperature regulators; Float and lever balanced valves, non-return valves, vacuum regulators or breakers; Strainers; Sirens; Safety valves. **Services**—Original settling of safety valves; automatic valve repairs.

Foxboro Company
Foxboro, Massachusetts
.....181, 182, 183, 184
Exhibiting: New Products—Consotrol instruments (indicating, recording, controlling) for graphic panel applications; Dynaformel pressure transmitter; Types 22 and 28 flow meters; Consotrol planimeter for 4" strip chart; d/p Cell with integral orifice for small flows; Stabilflo valves with side mounted brandwheels; Type 224 receiver-integrator counter; Conductivity cell. **Regular Products**—Multi-Record resistance dynalog recorder; Capacity dynalog recorder; EMF dynalog recorder, Dynatherm bulb.

Fulton Sylphon Division
Robertshaw-Fulton Controls Company
Knoxville 1, Tennessee....159, 160, 161
Exhibiting: Regular Products—Temperature controls; pressure controls, bellows assemblies; packless valves; heating and ventilating controls.

Gaertner Scientific Corporation
Chicago 14, Illinois.....303
Exhibiting: New Products—High precision cathetometer. **Regular Products**—Divided circle spectrometers, quartz spectrograph, linear comparator, micrometer slide comparator, Toolmakers' microscope.

Gamma-Brinkmann
Great Neck, L. I., New York 285
Exhibiting: New Products—Automatic balances (analytical); Exposure meter for photomicrography; Micro torsion balance; Vacuum pumps; Butler refractometer; Pulfrich type refractometer. **Regular Products**—Photomicrographic cameras, micro manipulators, microscopes, polarimeters.

Garden City Instruments Inc.
Chicago 5, Illinois 282
Exhibiting: New Products—Midget moisture meter for lumber and plaster. **Regular Products**—A.S.T.M. thermometers; A.P.I. hydrometers; Temperature, humidity and pressure indicators and recorders; Pyrometers; Timers; Process controllers; Bimetal dials; Industrial thermometers; Serdex-relative humidity instruments; Weksler thermometers and pressure gages; Seely process-control timers and valves; Pyrometer Instrument Co. optical, radiation and thermoelectric pyrometers; Weston moisture meters; Fisher-Tag oil testing instruments.

General Electric Company
Apparatus Sales Division
Schenectady 5, New York 222, 223, 224
Exhibiting: New Products—Recording Turbidometer, null system measuring ratio of scattered transmitted light as solution flows through sampling chamber; Dielectric Constant Chemical Analyzer; Crona "Sniffer." **Regular Products**—DP-11 and DP-12 testing instruments; Type B thickness gage; High-sensitivity portable galvanometer; H-P pyrometer; Hand pyrometer; Molecular vacuum gage; Leak detector; Photoelectric recorder; Delay line.

General Mills Inc.
Engineering Research and Development Dept.
Minneapolis 13, Minnesota 9
Exhibiting: New Products—Remote-controlled general purpose Manipulator, an electrically powered mechanical arm for remote handling of equipment in areas unsafe for personnel. **Services**—Facilities for research, development production in field of transducers, telemetering, electromechanical controls, remote-controlled manipulators and specialized precision instruments.

General Precision Laboratory, Inc.
Pleasantville, N. Y. 21
Exhibiting: New Products—Industrial television camera, resolution better than 400 lines, consisting of miniature camera and combined control unit and monitor. **Regular Products**—Special microwave components, adjustable voltage reference. **Services**—Design and construction of prototype units of special microwave components.

G. M. Giannini & Company
Pasadena 1, California 13, 14
Exhibiting: New Products—Angular Position Encoder, shaft position indicator utilizing a binary decimal coded commutator to actuate a relay system to give decimal read-out of shaft position; Spiralpot Potentiometer resistors with infinite resolution, true slide wire resistors in small sized cage, multiturn units with 0.01 percent linearity. **Regular Products**—Potentiometer resistors; accelerometers; Pressure transmitters; Pressure switches; Gyro transmitters; Aeroheads.

Russell T. Gilman Company
Milwaukee 11, Wisconsin 288, 289
Exhibiting: Regular Products—Gilman Quad-Matic Indexing Machine. **Services**—Special machine design.

Goodyear Aircraft Corporation
Akron 15, Ohio 57, 58
Exhibiting: Regular Products—GEDA line of analog computing equipment GN 215 L 3, GN 215 N 3, GN 215 R 5, GN 184 R 3, GN 215 T 1. Linear and non-linear electronic differential analyzers, recorders and input-output table.

Claud S. Gordon Company
Chicago 16, Illinois 292
Exhibiting: Regular Products—Insulated thermocouple wire; insulated lead wire; gages; thermometers; "Xactline" input controller; hand pyrometer, atmosphere indicator. **Services**—Industrial X-ray operator certified by U. S. Army Ordnance; Instrument repair & maintenance.

Gotham Instruments & United States Gauge Divisions of
American Machine and Metal, Inc.
Sellersville, Pa. 238, 239, 240
Exhibiting: New Products—Pneumatic remote-set control systems, including miniature transmitters, control systems and receivers, all units self-indicating; Direct-set recording and indicating controllers featuring newly designed 3-function responses. **Regular Products**—Commercial gages, high pressure gages (to 100,000 psi), laboratory test gages, industrial and dial thermometers, temperature and pressure recorders and controllers, high-pressure recorders (to 60,000 psi).

Gow-Mac Instrument Company
Madison 5, New Jersey 32
Exhibiting: New Products—Industrial Gas Master, portable relative thermal conductivity instruments with research quality cell unit; Fumigant Gas Master calibrated for methyl bromide; Gas Master Helper Unit for use with Industrial or Fumigant Gas Meter; Solder seal T/C gas sensing elements for hydrogen and helium reference in block of standard geometry, for recorder installations. **Regular Products**—Ever-Tite thermal conductivity gas sensing elements for production and portable instrument applications. **Services**—Development of special gas analyzing instruments.

Grayhill
La Grange, Illinois 98
Exhibiting: Regular Products—Switches, tap, push button, snap action, momentary contact; Thermosetting plastic parts, molded; Test clips, insulated alligator and panel mount. **Services**—Custom thermosetting plastic molding for small parts.

Green Instrument Company
Cambridge 39, Massachusetts 262
Exhibiting: New Products—Engraver which cuts five different sizes from one size of master type. **Regular Products**—Pantograph engraver, cutter grinder, rotary tables, drum dial fixtures, production holding fixtures. **Services**—Design and building for unusual production engraving problems.

W. & L. E. Gurley
Troy, New York 276
Exhibiting: New Products—Reticles; Divided circles and scales; Linear scales; Resolution test targets. **Regular Products**—Surveying instruments; Telescopic solar transit with display tripod, Optoplane precise transit (industrial model) with display tripod; Collimator; Engineers dumpy level with display tripod; Explorers' alidade; Testing Instruments: stiffness tester, sizing tester, S-P-S tester, permeometer; Meteorological instruments: wind velocity transmitter with calibrator, wind velocity indicator, wind direction transmitter, wind direction indicator; Hydraulic Engineering instruments: water current meter, Pygmy water current meter, water level recorder.

Hagan Corporation
Pittsburgh 30, Pa. 151, 152
Exhibiting: New Products—Pneumatic signal transmitter for use with Hagan ring balance meters; Electro-hydraulic pilot valve for high-speed heavy-duty positioner operation; Adjustable-speed program control. **Regular Products**—Hagan ring balance meters, recording, indicating, integrating and controlling; Hagan automatic controls for boiler combustion control, feed water control.

Hammel-Dahl Company
Providence 5, Rhode Island 155, 156
Exhibiting: New Products—Seal balanced holo plug angle valve; Flash flow plug; Continuously-connected side-mounted handwheel; Manually operated control valve. **Regular Products**—Control valves.

Hankison Corporation
Pittsburgh 16, Pennsylvania 117
Exhibiting: New Products—Liquifeeder constant-flow gravity-feed device for all liquids; Dehydrafilter, small desiccant filter with replaceable cartridge; Pipe line filters for removing entrained moisture from compressed air and gases. **Regular Products**—Condensifilter, model A-100-D and model B-30-D. **Services**—Compressed air engineering and consulting.

Hays Corporation
Michigan City, Indiana 177, 178
Exhibiting: Regular Products—Magno-Therm electronic O_2 recorder and analyzer, Condu-Therm electronic CO_2 recorder, Electronic flow meter, Miniscale miniature remote indicators, Draft and low pressure instruments.

Heiland Research Corporation
Denver 9, Colorado 253
Exhibiting: New Products—Amplifier System, 6-channel, carrier, linear/integrating; Bridge balance strain indicator unit, 6 channel; Miniature 12-channel recording oscillograph. **Regular Products**—Recording oscillographs; Galvanometers.

Helicoid Gage Division
American Chain & Cable Company
Bridgeport 2, Connecticut 127
Exhibiting: Regular Products—Helicoid gages, pressure, vacuum, chemical and compound ranges. Pressure indicators for industrial, chemical and oil refinery.

Hetherington and Berner Inc.
Indianapolis 7, Indiana 298
Exhibiting: New Products—Automatic batching "Fluidometer System," adaptable to practically any liquid measuring problem, controls batches from 1 to 10000 gal. **Regular Products**—Jacketed meters, fittings, pumps, pipe and hose. **Services**—Engineering and design of liquid measuring problems.

Hills-McCanna Company
Chicago 18, Illinois 230
Exhibiting: New Products—Valves with Teflon diaphragms for temperature and chemical resistance. **Regular Products**—Hills-McCanna Saunders Patent diaphragm valves; chemical proportioning pumps; force feed lubricators.

Carl Hirschmann Company
Manhasset, New York 288, 289
Exhibiting: Regular Products—Swiss precision tools and measuring instruments; Linear and circular dividing engines; Optical projectors and comparators; Gear and pinion cutters; Turret and toolroom lathes; Automatic screw machines; Pivot polishing machines; Jig boring machines.

Hoke Incorporated
Englewood, New Jersey 231
Exhibiting: New Products—Bellows valves for corrosive fluids or high vacuum service; Toggle valves, new sizes and for higher pressures; Bar stock needle valves; 3-way Valve, quick acting type; metering valves, accurate control of small flows. **Regular Products**—Precision needle valves; Instrument panel valves; Corrosion-resistant valves; Packless valves; Vacuum & pressure valves; Stainless steel cylinders; Flogages; Pressure regulators; Check valves; Blow torches, Oxy-gas.

Holger Andreasen, Inc.
San Francisco 3, California.....291
Exhibiting: New Products—Andrex lightweight portable x-ray units, capacities 120, 175 and 250 kvp, designed for continuous operation, can be connected to 110/220/440-v. supply. **Service**—Spare parts and service available.

Hughes Aircraft Company
Culver City, California 281
Exhibiting: New Products—Semi-conductor Products; Digital and analog computers (adaptation to industrial control); Memory devices; Telemetering equipment. **Regular Products**—Radar; Fire control systems; Guided missiles; Electron tubes; Germanium diodes.

Illinois Testing Laboratories, Inc.
Chicago 10, Illinois 65, 66
Exhibiting: New Products—Recording dew point instrument; Recording electric thermo-anemometer. **Regular Products**—Pyrometers, air velocity meters, dew point indicators, temperature controllers.

Imperial Brass Manufacturing Company
Chicago 7, Illinois 37, 38
Exhibiting: New Products—Hi-Duty Tube Fittings; Fittings for polyethylene tubing; Automatic shut-off for instrument lines; Bulkhead fitting; Cluster tubing junction box fittings; Diaphragm valve; Tube benders; Tubing and fitting repair kit; Refacing and flaring tools; Test plug for instrument lines. **Regular Products**—Brass and A1 Hi Duty fittings, flared, flex and Ermeto fittings, Hi-Duty shut-off valves; Plug and needle valves; Flexible hose and fittings; Tube cutters; full line of tools.

Industrial Control Panel Company
Chicago 11, Illinois 279
Exhibiting: New Products—Textile Machine Control Panel; Automatic Load Transfer Control Panel for emergency standby generator; Diesel Engine Starting Control Panel. **Regular Products**—Machine tool control panels; Process control panels; Sequence control panels; Engine cranking control panels; Load transfer control panels. **Services**—Design and engineering of control panels for any application.

Industrial Engineering Corporation
Louisville 8, Kentucky 172, 173
Exhibiting: New Products—Tachometer test stand to 10 000 rpm; Safety valve test stand; Multi-purpose research & development test unit; Servo amplifier for machine tool control; Automatic safety cut-off for pressure instruments. **Regular Products**—Instrument panels, aircraft and automotive test equipment, controlled process systems. **Services**—Research, development and consulting in instrumentation and functional product testing.

Industrial Instruments, Inc.
Cedar Grove, N. J. 122
Exhibiting: New Products—Model RI Indicator-controller-transmitter primarily designed for electrolytic solution conductivity. **Regular**

Products—Solu Bridge Controllers; Standard and special design conductivity cells.

Industrial Laboratories Publishing Company
Chicago 6, Illinois 118
Exhibiting: Publication—"Industrial Laboratories"

Industrial Pyrometer & Supply Company
Alton, Illinois 212, 213
Exhibiting: Regular Products—Insulated thermocouple lead wires; Insulated thermocouple wires; Bare thermocouple wires; Thermocouple connection heads; Thermocouple insulators; Thermocouple protection tubes.
In Attendance: Members of the organization.

Industrial Timer Corporation
Newark 5, New Jersey 33, 34
Exhibiting: Regular Products—Electrical timing devices.

Industrol Corporation
Roselle Park, New Jersey 110
Exhibiting: New Products—Stainless steel sample system dryer for removal of moisture from gas sample upstream of analyzer. **Regular Products**—Dynamic dehumidifier; Centrisorb air filters; Process pilot plants.

Institute of Radio Engineers
New York 36, N. Y. .....144 A
Exhibiting: Featuring I.R.E.'s Professional Groups on Instrumentation. Pins. "Proceedings of the I.R.E."

Instrof Incorporated
Philadelphia 43, Pennsylvania 274, 275
Exhibiting: New Products—Instrof prefabricated system of metal trough, fittings and covers for instrument wiring or tubing, cuts down design and installation time, provides flexibility and maximum mechanical protection.

Instron Engineering Corporation
Quincy 19, Massachusetts 294, 295
Exhibiting: New Products—Instron Integrator providing accurate time-integral of any d.c. input function, or integration of two independent variables with respect to each other; X-Y Recorder Drive for converting standard recorders without sacrificing X-time bases, may be used for obtaining true stress-strain curves; Extensometers for tensile and compression specimens. **Regular Products**—Universal Tensile Tester.

Instrument Laboratory Service
Cleveland 11, Ohio 284
Exhibiting: New Products—Electronic Glow Transfer Millisecond Timer for measurement of elapsed time by counting pulses from a precision 1000-cycle tuning fork and displaying the count by decimal counting tubes. **Regular Products**—Electronic Tachometers; electric tachometer systems; explosion-proof housings; servo control systems; interval timers; impulse counters; explosion-proof switches and controls. **Services**—Product development, test equipment design, overhaul service of aircraft instruments.

Instruments Publishing Company
Pittsburgh 12, Pennsylvania 75, 76, 77
Exhibiting: "Instruments," the Magazine of Measurement, Analysis, Computing, Inspection, Testing & Control; "The Instrument Index," the bi-annual buying directory for instrument users and buyers; "Instrument and Apparatus News," the Magazine of Instruments, Scientific Equipment, Components and Services; "Instrument Manufacturing," the trade journal of the Instrument Industry; "Instrument Manufacturing Guide," the bi-annual directory of the parts manufactured for the Instrument Industry; "The Handbook of Measurement and Control." Books: "Electronic Circuitry for Instruments & Equipment" by M. H. Aronson; "Applications of Industrial pH Controls" by A. L. Chaplin; "Elementary Engineering Electronics" by A. W. Kramer; "Heat Inertia in Problems of Automatic Control of Temperature" by V. Broida; "Instrumentation for the Iron & Steel Industry" (1st and 2nd Proceedings); "Instrumentation for the Process Industries" (1950, 1951 and 1952 Proceedings); "Maintenance & Servicing of Electrical Instruments" by J. Spencer; "Mechanical Measurements by Electrical Methods" by H. C. Roberts; "Operation & Care of Circular Scale Instruments" by J. Spencer; "Scientific & Industrial Glass Blowing & Laboratory Techniques" by Barr and Anhorn; "Electronic Control Handbook" by Batcher & Moulic.

Instrument Society of America
Pittsburgh 33, Pennsylvania ....Lobby
Exhibiting: I.S.A. Publications—1950, 1951, 1952 Proceedings; Recommended Practices; Industrial Instrument Training Course Outline; Principles of Automatic Control; Copies of 1953 Reprints.

Jerguson Gage & Valve Company
Somerville 45, Massachusetts 210
Exhibiting: New Products—Remote-reading "Truscale Gage" for panel mounting allowing 180 degree visibility; Liquid level gages; Automatic shut-off valves; Instrument piping valves. **Regular Products**—Liquid level gages and valves.

Jordan Regulator Corporation
Cincinnati 2, Ohio 278
Exhibiting: New Products—Complete new line of pressure and temperature controls and mixing valves, patented sliding gate design incorporated in all products. **Regular Products**—Pressure reducing valves; temperature control valves; back pressure and relief valves; temperature control mixing valves; shower bath valves.

Karn Chemical Equipment Company
Pittsburgh 2, Pa. 259
Exhibiting: Regular Products—Thermometer wells, thermocouple wells, thermocouple assemblies.

W. A. Kates Company
Deerfield, Illinois 68
Exhibiting: New Products—Flow rate regulator for slurries. **Regular Products**—Kates flow rate regulators.

Kieley & Mueller, Inc.
Middletown, New York 80, 81
Exhibiting: New Products—Chemically-resistant valves; Sweep flow Venturi angle valves; Diaphragm-motor-operated butterfly valves; Side-mounted handwheel-operated motors; Pressure controller. **Regular Products**—Diaphragm control valves; Direct-connected pressure regulators.

Lancaster Lens Company
Lancaster, Ohio 300
Exhibiting: New Products—Glass bulbs for radar, oscilloscope and kinescope tubes; miniature glass parts; Screened dials and scales. **Regular Products**—Meter covers; Ground & polished optics for instruments; Miscellaneous instrument glass parts.

Lapp Insulator Company
Process Equipment Division
Leroy, New York 51, 52
Exhibiting: New Products—Auto-Pneumatic Pulsafeeder controlled-volume pump with new air cylinder. **Regular Products**—Pulsafeeder (manually controlled); Auto-Pneumatic Pulsafeeder (instrument controlled).

Leeds and Northrup Company
Philadelphia 44, Pa. 194, 195, 196
Exhibiting: New Products—Thermo-magnetic Oxygen Analyzer, measures percentage of oxygen in flue gas from boiler plant furnaces and refinery process heaters, used with Speedomax Recorder and sampling unit; Recording Spectrophotometer improved in ruggedness, compactness, optical quality and simplicity of construction and adjustment. **Regular Products**—Speedomax Demonstrator.

Leslie Company
Lyndhurst, New Jersey 111, 112
Exhibiting: Regular Products—Regulators; Diaphragm control valves; Pressure reducing valves; Floatless level controls; Temperature regulators; Pressure controllers; Pump governors; Self-cleaning strainers.

Librascope Incorporated
Glendale 1, California 22
Exhibiting: New Products—Square root planimeter for flow chart totalizing and cost accounting; X-Y Plotter for curve drawing or point plotting of analog or digital data, demonstration from punched cards; Sine Wave Generator (mechanical) with continuous adjustment of frequency, amplitude, and center position, 72000-to-1 frequency range; Industrial magnetic amplifier, controlling a 0.9 peak h.p. 3-phase motor from a 10 milliwatt input; Computer Potentiometers featuring close tolerances; Analog to digital and digital to analog converters, resolution may be extended to 1 part in 64000. **Regular Products**—Mechanical and electrical analog computers, digital computers, computer components. **Services**—Research, development and manufacture of computers and control systems.

J. E. Lonergan Company
Philadelphia 6, Pennsylvania 211
Exhibiting: New Products—Model 41W-200 Series ASME-approved safety valves. **Regular Products**—V-Series and W-Series safety-relief valves; "Maximon" Series pressure gages.

Magnetrol, Incorporated
Chicago 23, Illinois 178-A
Exhibiting: New Products—Three-way reversible air valve magnetically operated, to be used on Magnetrol actuators; Flow alarm switches. **Regular Products**—Liquid level controls, float or displacement type. **Services**—Consulting service on liquid level control applications.

Manning, Maxwell & Moore, Inc.
Stratford, Connecticut 1, 2
Exhibiting: New Products—Electronic process control systems for temperature, pressure, differential pressure, liquid level and flow. **Regular Products**—Industrial instruments, pressure gages, safety and relief valves, globe, angle and gate valves.

Marine and Industrial Products Company
Chicago 21, Illinois 78, 79
Exhibiting: New Products—All-Teflon hand and motorized valves (all wetted parts machined from Teflon bar stock); Valves machined for Koncentric fittings. **Regular Products**—Safety and relief valves, needle, globe, solenoid, solenoid air cylinder, electric motor; Diaphragm valves; Special design valves for high pressure, temperature and corrosive service. **Services**—Engineering and design of special valve applications.

Mason-Neilan Regulator Company
Boston 24, Mass. 201, 202, 203
Exhibiting: New Products—12800 Series liquid level controllers, displacement-type measuring element, deflection-balance control mechanism, affords unusual control accuracy and sensitivity in level ranges from inches to feet. **Regular Products**—Control valves, control instruments.

MB Manufacturing Company
New Haven 11, Connecticut 169, 170
Exhibiting: New Products—Miniature MB Type 10 Vibration Pickup with electromagnetic damping, accurate over wide temperature range. **Regular Products**—Vibration pickups and meters; Vibration exciters; Isomode mounts. **Services**—Custom-designed equipment for vibration control, measurement, and reproduction.

McAlear Manufacturing Company
Chicago 8, Illinois 174, 175
Exhibiting: New Products—Pressure regulators and diaphragm-motor valves. **Services**—For steam, air, gas, oil & water.

Measurements Corporation
Boonton, New Jersey 53
Exhibiting: New Products—Model 84-TV standard signal generator covering range of 300 to 1000 Mc. **Regular Products**—Intermodulation meter; UHF radio noise & field strength meter; Megacycle meter; Vacuum tube voltmeters; Signal generators; Pulse generator; Crystal calibrators; High-frequency barretter; R.f. Attenuators; I.f. Converter. **Services**—special equipment built to specifications.

Meriam Instrument Company
Cleveland 2, Ohio 44, 45
Exhibiting: New Products—Pressurized manometer for accurate pressure measurements to 600 inches mercury. Manometer models with full scale vernier arrangement. **Regular Products**—Manometers.

Micro Switch
Division Minneapolis Honeywell

Regulator Company
Freeport, Illinois 225, 226
Exhibiting: New Products—Subminiature snap-action switch, handles 5 amperes; Hermetically-sealed s-p. d-t. snap action switch for hazardous locations; Subminiature toggle switch; Rotary gang selector switch giving a multitude of sequences; Toggle switch assembly consisting of eight s-p. d-t. switches. **Regular Products**—Limit, safety, control switches; Explosion-proof switches; Foot- and hand-operated switches; A.N. toggle switches; variety of precision snap acting basic switches.

Midwestern Geophysical Laboratory
Tulsa, Oklahoma 227
Exhibiting: New Products—Model 580 14-channel Oscillograph flight-test instrument, equally useful in other applications; Model 4 hydraulic servovalve, twin-piston design gives smooth operation under vibration; Model 9 torque motor converts a few watts of power from electronic amplifier into linear mechanical motion. **Regular Products**—Oscillographs; Multi-Dynamic meter; Galvanometers; Hydraulic servo components; Amplifiers.

William Miller Instruments Inc.
Pasadena 8, California 136
Exhibiting: New Products—Model A-6 amplifier system and multi-channel recording oscillographs. **Regular Products**—Galvanometers, amplifiers, recording oscillographs. **Services**—Instrument development and manufacture.

Milton Roy Company
Philadelphia 18, Pennsylvania 250, 251
Exhibiting: New Products—Mini Pump Submersimetric units handling up to 1000 ml/hr, liquid end completely submerged; no possibility of fluid leakage to atmosphere. **Regular Products**—Motor-driven controlled-volume pump with dial or motorized micro stroke length adjustment; MiniPump Simplex; MiniPump Constanetric; MiniPump with pneumatic stroke length adjustment; Air-operated proportional feed system; Motor-driven controlled-volume pump with variable-speed motor pneumatically controlled.

Mine Safety Appliances Company
Pittsburgh 8, Pennsylvania 3, 4
Exhibiting: Regular Products—Oxygen analyzer; Combustible gas analyzer; Infrared analyzer; Carbon monoxide analyzer; Portable dust, combustible gas and toxic gas indicators.

Moore Products Company
Philadelphia 24, Pa. 139, 140, 141
Exhibiting: New Products—M/P Station with plug-in Nullmatic controllers; Externally-mounted valve positioner with diaphragm-operated pilot; Pneumatic pressure transmitter; Air-purge controller; Fabricated graphic panels. **Regular Products**—Nullmatic pressure regulators; Pneumatic comparator gages; Nullmatic temperature transmitter; Nullmatic differential pressure transmitter; Liquid-level controller.

Samuel Moore & Company
Dekron Tubing Division
Mantua, Ohio 43
Exhibiting: New Products—Junction boxes for use with Dekoron Impervapak, entry grommets, clamps and miscellaneous items for installing Dekoron Impervapak, Metl-Cor and Poly-Cor. **Regular Products**—Dekoron coated instrument tubing; Dekoron Impervapak; Dekoron coated conduit.

Murphy & Miller, Inc.
Chicago 8, Illinois 264
Exhibiting: New Products—Environmental chamber for high temperature, low temperature and humidity. **Regular Products**—One cu. ft. cabinet for operation to minus 130 degrees F; Four cu. ft. cabinet for operation to minus 130 degrees F.

Nash Engineering Company
South Norwalk, Connecticut 142, 143
Exhibiting: Regular Products—Nash Instrument Air Compressors.

National Bureau of Standards
Washington 25, D. C. 265
Exhibiting: New Products—Electronic flowmeter; Electron-beam interferometer; Instruments for research developed in NBS laboratories.

New Hermes Engraving Machine Corporation
New York 3, New York 64
Exhibiting: New Products—Engravograph engraving machine. **Regular Products**—Bench type and portable engraving machines for engraving on nameplates, dials, panels, milling, profiling, on all metals and plastics.

North American Philips Company
Mount Vernon, New York
.....191, 192, 193
Exhibiting: New Products—X-ray Spectrograph for quantitative disclosures of single elements approaching one part in millions. **Regular Products**—Electron microscope; X-ray diffraction, X-ray diffractometer. Apparatus in actual operation.

Nuclear Instrument and Chemical Corporation
Chicago 10, Illinois 258
Exhibiting: New Products—Process control instruments utilizing radioisotope techniques.

Ohmart Corporation
Cincinnati 38, Ohio 252
Exhibiting: New Products—Ohmart Cells combined with radioactivity to measure various functions of density, four types of applications to be shown. **Regular Products**—Ohmart Cells; Gammometers; amplifiers.

Palmer Thermometer, Inc.
Cincinnati 12, Ohio 46, 47
Exhibiting: Regular Products—Complete line of industrial, laboratory, dial and recording thermometers.

Panalarm Products, Inc.
Chicago 40, Illinois 204, 205, 206, 207
Exhibiting: New Products—Universal Panalarm "50" multi-purpose annunciators featuring new low-drain and lock-out type circuits. **Regular Products**—Signal systems, level indicators (illuminated), manual loaders. **Services**—Engineering, design and fabrication of alarm systems.

Panascan, Incorporated
Chicago 40, Illinois 204, 205, 206, 207
Exhibiting: New Products—Circuit Seeker, Model CS-10, automatic electrical system which offers high speed identification of individual conductor ends or circuits in electrical cables or wired assemblies. **Regular Products**—Monitoring and scanning systems, electric testing systems. **Services**—Engineering, design and fabrication of monitoring system.

Panellit, Inc.
Chicago 40, Illinois 204, 205, 206, 207
Exhibiting: New Products—Special graphic panel, completely piped and wired. **Regular Products**—Graphic panels, standard panels, cubicles. **Services**—Engineering, design and fabrication of complete control systems.

Parker Appliance Company
Cleveland 12, Ohio 93, 94
Exhibiting: New Products—Hoze-lok reusable fittings for cotton-covered single-wire-braid hose and for single- and double-wire-braid rubber-covered hose; Precision molded rubber parts; Power tube flaring machine. **Regular Products**—Tube fittings, tube working tools, synthetic rubber O-rings.

Penn Industrial Instrument Corporation
Philadelphia 4, Pennsylvania 180
Exhibiting: New Products—Telephone-line long-distance telemetering equipment; Pneumatic indicating pressure transmitters. **Regular Products**—Flow meters; Recording thermometers; Recording pressure gages; Automatic controllers; Pneumatic and electric transmitters for temperature, pressure, level and flow; Pressure-gage pneumatic transmitters; B.T.U. meters; Three-element boiler drum level control; Complete ratio control systems.

Perkin-Elmer Corporation
Norwalk, Connecticut 35, 36
Exhibiting: New Products—Model 14 Spectrometer; Model 93 Bichromator; Model 105 Tri-Non. **Regular Products**—Optical and electromechanical instruments; Spectrometers; Spectrophotometers; Electrophoresis apparatus; Flame photometer. **Services**—Engineering design and development of optical and electromechanical instruments.

Permutit Company
Ranarex Division
New York 36, New York 15
Exhibiting: New Products—Ranarex gas analysis instruments combined with Fischer & Porter pneumatic transmitter and secondary equipment for remote indicating and recording or automatic control. **Regular Products**—CO_2 meters; Gas specific gravity instruments; Furnace atmosphere analyzers; Industrial process gas analyzers.

Potter Aeronautical Company
Newark, New Jersey 71, 72
Exhibiting: New Products—Predetermined electronic totalizer; Flowmeter with density adjustment; Airborne flowmeters; electronic counters; Industrial flow control system. **Regular Products**—Laboratory and industrial type equipment, tachometers, flow-sensing elements.

Potter Instrument Company
Great Neck, New York 260
Exhibiting: New Products—Model 860 10-Mc. Frequency Counter, measures frequencies from 10 cps. to 10 Mc. in increments of 0.1 microsecond; Model 960 Digital Recorder, high speed, up to 150 eight-digit numbers per second; Model 901 Digital Magnetic-tape Handler, for ¼" and ½" tape, two speeds 15" and 30" per second, fully reversible, automatic or manual control. **Regular Products**—Frequency time counters, 8-Mc. counter chronograph, dual predetermined counter.

Process Control Division of Baird Associates, Inc.
Cambridge 38, Massachusetts 70A, 70B
Exhibiting: Regular Products—Plant Stream Analyzer, infrared absorbing type.

Production Instrument Company
Chicago 6, Illinois 40
Exhibiting: Regular Products—Counters, mechanical, electric and automatic batch. Actuating switches for electric counters; Electric eye actuators.

Proportioneers, Inc.
Providence 1, R. I. 115, 116
Exhibiting: New Products—Working model of drum size Loss-In-Weight unit for liquid handling of additives in the chemical process and refinery fields; Flow-response or constant-rate Two Component Blender for adding up to 8 percent of additives regardless of rate of flow; Redesigned Micro-Feeder low-capacity high-accuracy high-pressure metering pump. **Regular Products**—Motor-driven Adjust-O-Feeder proportioning pump; Pneumatically-operated Treet-O-Control-Treet-O-Unit proportioning and metering pump. **Services**—Engineering on proportioning and metering problems in chemical and process fields.

Radio Corporation of America
Camden, New Jersey 137
Exhibiting: New Products—RCA Industrial Television including many accessories for power and industrial application of closed-circuit TV.

Republic Flow Meter Company
Chicago 47, Illinois 84, 85, 86
Exhibiting: New Products—Low-pressure calibrator for pressure, vacuum and differential-pressure gages up to 20" water range; Medium-pressure calibrator for pressure, vacuum and differential gages in ranges between 0-20 inches water and 0-25 psig; Compact type vertical-scale draft gage. **Regular Products**—Model P-0307 and P-0321 differential-pressure transmitter; Telemaster electronic master combustion control system; Type E electric flow meter; Model CDD oil sealed bell type draft recorder; Model SG73LD air-operated positioner for large dampers; Model 678 furnace pressure regulator.

Research Controls
Tulsa, Oklahoma 87
Exhibiting: New Products—Pneumatic flow valves and instruments for pilot plant, research, and special flow applications. **Regular Products**

—Extremely low flow miniature pneumatic flow valves; characterized plugs, renewable trim in most any material for corrosion resistance. Standard body ratings to 4000 psi; Miniature control instrument accessories. **Services**—Special design valves and instruments.

Roanwell Corporation
Brooklyn 17, New York 280
Exhibiting: New Products—Aerosensor air gage, continuously measures and records thickness variations of paper, foil, etc., as manufactured, accuracy within 15 microinches; Confidencer, noise-cancelling microphone, transmits speech while neutralizing unwanted noises. **Regular Products**—Telephone handsets, hangers, switchbox hanger assembly; Waterproof field telephone handsets; A-N headsets; Thru cord switches; Gas mask microphone assembly; Noise cancelling mobile microphones; Carbon and magnetic microphones; Magnetic receivers. **Services**—Design and engineering for communications terminal apparatus field.

Robinson Aviation, Inc.
Teterboro, New Jersey 16
Exhibiting: New Products—Met-L-Flex all-metal vibration isolation and shock control systems for instruments and miniature equipment. **Regular Products**—Vibration isolation and shock control systems; units and devices designed and manufactured to government specifications. **Services**—Engineering, consultation and design.

Rockwell Register Corporation
Macnick Division
Tulsa 10, Oklahoma 263
Exhibiting: New Products—Emcorector; Flow prover; Combined record gage; Flow indicating meter. **Regular Products**—Chart drives, differential controllers, valves, orifice meters, integrator. **Services**—For gas, oil and chemical industries.

Scientific Apparatus Makers Association
Chicago 6, Illinois 68-A
Exhibiting: SAMA is the American association of companies manufacturing and distributing laboratory and industrial instruments, apparatus, equipment and supplies.

Servomechanisms, Inc.
Westbury, New York 5, 6
Exhibiting: New Products—Magnetic amplifiers; Error recorder (pot checker); Axial flow blowers; Gear head motors. **Reular Products**—Instrument and servo motors; Mechanical development apparatus; Hermetically sealed servo amplifiers; Power supplies; Positioning mechanisms; Transducers; Complete servo systems for military and industrial applications. **Services**—Development, design and manufacture of electronic and electromechanical components and systems for military and industrial applications.

Shand and Jurs Company
Berkeley 10, California 50
Exhibiting: Regular Products—Remote-reading automatic tank gage system. Impulse type "Varioplex."

Sherman Electric Company
Warren, Ohio 261
Exhibiting: New Products—"Restorer" for protection against thermocouple failures; Thermocouple protection-tube Checker.

South Bend Lathe Works
South Bend 22, Indiana 118A
Exhibiting: New Products—Pedestal Grinder with safety-glass eye-shield and two lights in frame, spindle bearings independent of motor bearings; Indexing table, each graduation indicates table movement of 3 min.; Indexing Centers; Universal Table for use with milling machine, drill press, etc. **Regular Products**—10-in. toolroom lathe; 14-in. precision drill press; 7-in. bench shaper; machine tool attachments.

Special Screw Products Company
Bedford, Ohio 254
Exhibiting: New Products—Stainless valves (Mfgd. by Wm. Powell Co.) machined for tubing using Koncentrik tube fittings. **Regular Products**—Koncentrik stainless tube fittings.

Standard Electric Time Company
Springfield 2, Massachusetts 10
Exhibiting: New Products—Electronic Tachometer & Counter, range up to 1,000,000 pulses, operated from photoelectric, magnetic, electrical or electromechanical pickups. **Regular Products**—Precision electric timers; Chrono-Tachometers; Strobo-Check tachometers; Electronic tachometers.

Streeter-Amet Company
Chicago 13, Illinois 244, 245
Exhibiting: New Products—Electric-Eye TRAFicounter counts vehicles with photoelectric beams; Analog data recorder prints numerical values of analog measurements; Printing power demand meter gives numerical record of electric power demands. **Regular Products**—SCI counter recorder (pulses), TIMcounter recorder (time interval), REVcounter recorder (revolution); Electronic scales and recording instruments; RC-PC-JR-PSI TRAFicounters.

Superior Electric Company
Bristol, Connecticut 62, 63
Exhibiting: Regular Products—Powerstat variable transformers; Stabiline automatic voltage regulators; Voltbox a-c. power supplies; Varicell d-c. power supplies; Superior 5-way binding posts.

Superior Tube Company
Norristown, Pennsylvania 134
Exhibiting: New Products—Seamless large-OD light-wall tubing in sizes up to 2-1/16" OD in three stainless steels and in Monel metal. **Regular Products**—Wide variety small-diameter tubing in many steels, nickel and nickel alloys, beryllium copper and titanium; Types include hypodermic needle, Bourdon, hydraulic, superpressure, micro-precision, and special shapes.

Surprenant Manufacturing Company
Boston 8, Massachusetts 208, 209
Exhibiting: New Products—Extruded thinwall Teflon insulated hook-up wire continuously operable from minus 90 deg. C. to 210 deg. C. without appreciable deterioration; Improved light-weight smaller-diameter aircraft wire (vinyl-glass braid-nylon). **Regular Products**—Extruded Teflon hook-up wire, coaxial cables, miniature wire and cables, multi-conductor cables, Surflene (Kel-F) insulated hook-up wire, aircraft wire, Spiralon, Surco A-10 (105 deg C.) hook-up wire, Surco tubing, MIL-W-5274 A aircraft, radar, electronic hook-up wire.

Swartwout Company
Cleveland 12, Ohio 144, 145
Exhibiting: Regular Products—Autronic Controllers, recorders and transmitters.

Swiss Jewel Company
Philadelphia 6, Pennsylvania 255
Exhibiting: Regular Products—Jewel bearings, highest-quality closest-tolerances ruby and sapphire bearings.

Taylor Instrument Companies
Rochester 1, New York 131, 132, 133
Exhibiting: New Products—Transaire differential pressure transmitter; Linear flow recorder; Graphic panel; Taylor load elements. **Regular Products**—Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.

Technical Charts, Inc.
Buffalo 10, New York 101
Exhibiting: Regular Products—Charts, dial, roll and rectangular, for all types of recording instruments. **Services**—Over 8000 different chart items.

Telechron Department
General Electric Company
Ashland, Massachusetts 67
Exhibiting: Regular Products—Synchronous timing motors; Timers; Instruments.

Telecomputing Corporation
Burbank, California 146, 147
Exhibiting: New Products—Contact Telereader for large records, may be equipped to operate analog or digital devices; Teleducer, electromechanical voltage-to-digit converter, speed 0.5 to 0.8 second per reading. **Regular Products**—Teleplotter; Universal Telereader; Linear Calibrator; Telecorder; Magnetic reading head (shaft position digitizer). **Services**—Data analysis and computing service to industry, science and the Government.

Thermo Electric Company
Fair Lawn, New Jersey 59
Exhibiting: New Products—Indicating and recording pyrometers; Signaling type controllers potentiometer or Wheatstone bridge type; Temperature monitoring system; Thermocouple harness for jet engines. **Regular Products**—Industrial and aircraft thermocouples and extension wire; connector panels; quick-coupling connectors.

Tigerman Engineering Company
Chicago 18, Illinois 229
Exhibiting: New Products—Tele-Counter for totalizing and selecting abnormal alarm signals; Tel-A-Unit universal all-purpose alarm systems. **Regular Products**—Telalarm annunciators, Tigerbilt mercury safety switches, Safelock receptacles.

Tobi N. V. Technisch Ontwikkelings Bureau Voor Instrumentatie
Keizersgracht 345A, Amsterdam-C, Netherlands 249
Exhibiting: Tobi Engineers develop and build special electronic, electrical and pneumatic instruments for industrial control.

Trimount Instrument Company
Chicago 12, Illinois 286
Exhibiting: New Products—Crown Hydratrol Controls, hydraulic remote controls and positioning equipment. **Regular Products**—Well type manometers; multiple tube manometers; absolute pressure manometers; U-tube manometers, liquid level gages; indicating flow meters; orifice plates and flanges.

Trinity Equipment Corporation
Roselle Park, New Jersey 109
Exhibiting: New Products—Double bore Thermowells to permit precise checking without removal. **Regular Products**—Thermocouple wells; Thermometer test wells; Protection tubes; Separable sockets for thermometers.

Uehling Instrument Company
Patterson, New Jersey 171
Exhibiting: New Products—Tel-Flo Meter, suitable for maximum pressures of 300 psi. or higher, with or without control valve; **Regular Products**—Liquid level, pressure and vacuum indicators and recorders; Mercurial barometers, Draft gages; Manometers; Absolute pressure recorders.

Unistrut Products Company
Chicago, Illinois 216, 217
Exhibiting: New Products—Tubing clamps and other accessories. **Regular Products**—Unistrut System of all-purpose adjustable metal framing and mechanical support.

United States Gauge and Gotham Instruments Divisions of American Machine and Metals, Inc.
Sellersville, Pa. 238, 239, 240
Exhibiting: New Products—Pneumatic remote-set control systems, including miniature transmitters, control systems and receivers, all units self-indicating; Direct-set recording and indicating controllers featuring newly designed 3-function responses. **Regular Products**—Commercial gages, high pressure gages (to 100,000 psi.), laboratory test gages, industrial and dial thermometers, temperature and pressure recorders and controllers, high-pressure recorders (to 60,000 psi.).

Vapor Recovery Systems Company
Compton, California 241, 242, 243
Exhibiting: Regular Products—Mechanical automatic tank gages; Electronic tank gaging equipment.

Veeder Root, Inc.
Hartford 2, Connecticut 125, 126
Exhibiting: New Products—Veeder Vary-Tally, multiple bank of small reset counters for various checking purposes. **Regular Products**—Mechanical counters; Magnetic counters; Hand counters; Navigational, fire control and aircraft counters; Measuring and textile counters.

Wallace & Tiernan Company
Newark, New Jersey 102, 103
Exhibiting: New Products—Massometer, force-balance instrument for accurately measuring flow-rate flow of free-flowing materials. **Regular Products**—Merchen Scale Meter; Absolute pressure indicators; Manometers and barometers; Pressure gages; Absolute pressure controller.

Ward Leonard Electric Company
Mount Vernon, New York 247-A
Exhibiting: Regular Products—Resistors, rheostats, relays, motor control, theatre dimmers.

Weatherhead Company
Cleveland 8, Ohio 88, 89
Exhibiting: New Products—New type low pressure reusable hose and end couplings; Hose coupling equipment. **Regular Products**—Brass tube and pipe fittings, brass shut-off valves, Ermeto steel and stainless steel fittings, hose assemblies, brass and steel reusable hose end couplings. **Services**—Engineering, product application and installation.

Webber Manufacturing Company
Indianapolis 3, Indiana 8
Exhibiting: New Products—Cubic foot bench type testing unit for low and high temperature testing, rapid temperature changes, minus 100 F. to plus 250 F. **Regular Products**—Industrial low temperature freezer capable of reaching minus 165 F., humidity, vacuum, high temperature optional. **Services**—Custom built to exact specifications environmental chambers, humidity cabinets, high & low temperature units.

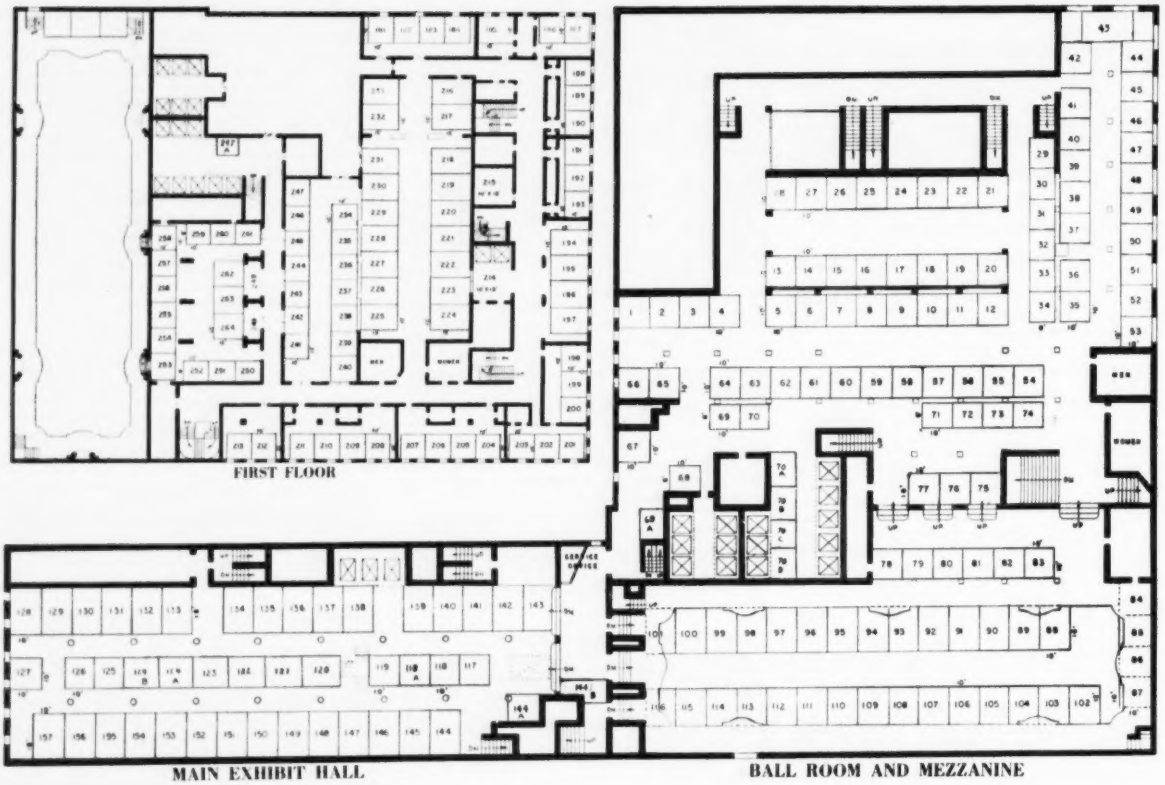
W. M. Welch Manufacturing Company
Chicago 10, Illinois 73, 74
Exhibiting: New Products—Stable, sensitive photoelectric densitometer for quantitative paper chromatography and electrophoresis, complete with voltage-controlled light source, paper guide and paper-advancing mechanism. **Regular Products**—Duo-Seal vacuum pumps, Densichron densitometer and related equipment; laboratory scales; electrical measuring instruments.

West Instrument Corporation
Chicago 22, Illinois 123
Exhibiting: New Products—Stepless controllers having power outputs from 0-300 watt capacity to 0-100 kva. capacity; Program controller. **Regular Products**—Gardsman pyrometric temperature controllers: Model J off-on, Model J P proportioning, Model J L high limit, Model J T three-position.

Weston Electrical Instrument Corporation
Newark 5, New Jersey 246, 247
Exhibiting: Regular Products—Electrical indicating instruments; Relays; Thermometers; Light-measuring instruments; Recorders and controllers.

Yarnall-Waring Company
Philadelphia 18, Pennsylvania 138
Exhibiting: New Products—Yarway Liquid Level Indicator for remote location and operation by primary indicator on boiler room panel; Television equipment for use with Yarway water level gages. **Regular Products**—Yarway high-pressure water column and gage; Yarway remote liquid level indicator and recorder.

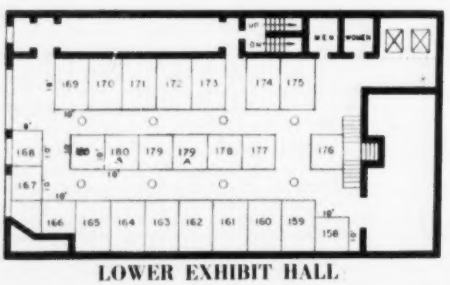
EXHIBIT FLOOR PLAN



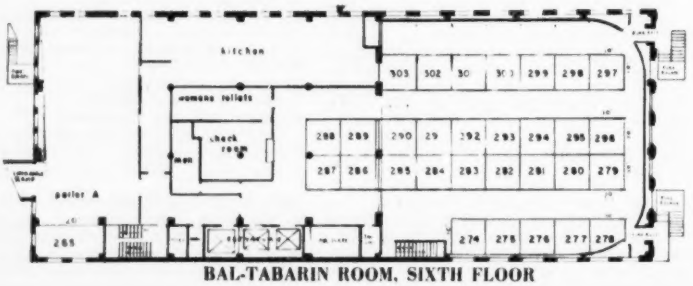
FIRST FLOOR

MAIN EXHIBIT HALL

BALL ROOM AND MEZZANINE



LOWER EXHIBIT HALL



BAL-TABARIN ROOM, SIXTH FLOOR

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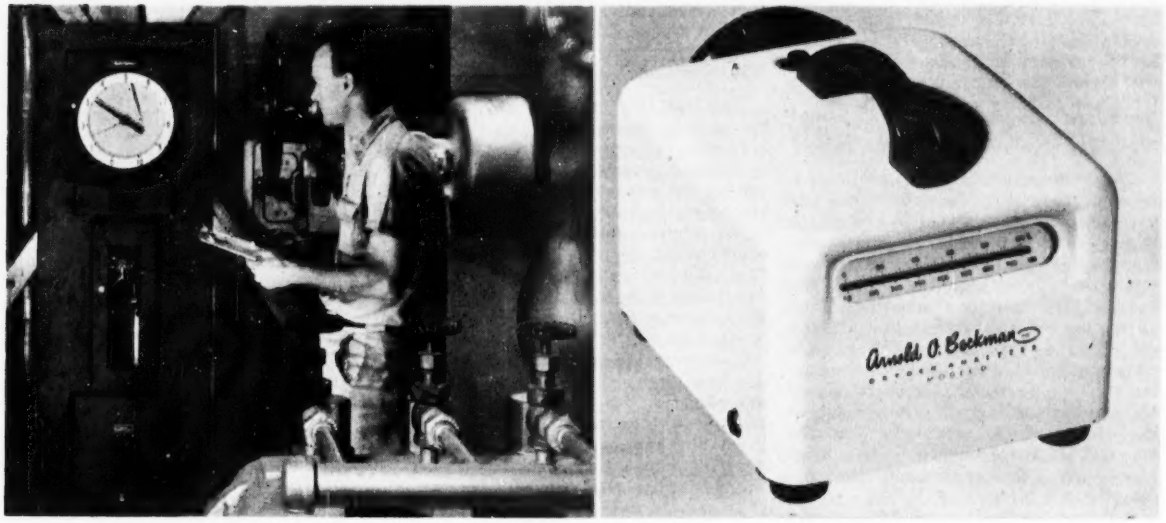

Fig. 1. (Left), paramagnetic-principle oxygen analyzer of automatic-balance null-balance type; (right), portable paramagnetic-principle oxygen analyzer of deflection type.

OXYGEN MEASUREMENT

By OWEN K. SEFFERN
Arnold O. Beckman, Inc.

OXYGEN measurement and control are important industrial considerations. Among the industrial operations in which oxygen plays an important part are such applications as:

(1) *Quality control*—The atmospheres in ceramic kilns and in other furnaces and heating equipment must be closely regulated in order to insure a high-quality product as well as to operate with maximum fuel economy.

(2) *Purity control*—In gas manufacture and transportation it is essential not only from the purity control outlook, but often from the safety standpoint, that the oxygen content of the gas be kept within certain limits.

(3) *Industrial safety*—Many hazardous conditions can be alleviated by keeping the oxygen concentrations low in the surrounding atmosphere; the controlled purging of the headspace in fuel and chemical storage tanks and the purging of natural gas lines during repair are two examples.

(4) *Combustion processes*—Steam generators, oil heaters, cat-cracker catalyst regenerators, and countless others can be included in this group of operations where maximum output per fuel dollar is important.

Some time ago the primary method used to determine combustion efficiency involved the measurement of carbon dioxide. In the last few years, however, reliable methods of continuous oxygen measurement have been developed which have already replaced carbon-dioxide determinations. This change is attributed not only to the reliability of the oxygen-measuring instruments, but also to the difficulty in interpreting carbon-dioxide concentration in terms of excess air. As can be seen in Fig. 2 the carbon-dioxide concentration varies with the hydrogen-carbon ratios of fuel being burned. These large differences, inherent in the carbon-dioxide method, make determinations of combustion efficiency difficult at best, and virtually impossible if fuel mixtures are being used. The chart shows that in the normal combustion range of oxygen, and regardless of fuel burned, an accurate and reliable picture of the excess air present can be obtained by determining the oxygen concentration.

The methods of measuring oxygen differ not only in type, but also in accuracy and reliability. This article describes the method of direct oxygen measurement using the paramagnetic technique. A brief explanation of other common methods also is given.

Orsat Technique

The Orsat principle of measuring oxygen is probably the oldest technique utilized. It is a volumetric method and involves trapping a gas sample and carefully measuring its volume. The sample is passed through a carbon-dioxide absorbing medium and the volume is measured again. The difference in volume is a measure of the carbon-dioxide concentration. The gas sample then is passed through an oxygen-absorbing medium. The difference between this volume and the previous one is the oxygen concentration.

September Meeting: Saturday, the 19th, Rio Hondo Country Club, Downey, Calif.

Feature: The 26th annual Low Jinks and golf tournament.

Detector Cell

The detector-cell type of instrument consists essentially of a primary cell which has a metallic electrode and a hollow carbon electrode immersed in an electrolyte. During the operation, the generated current is decreased as the primary cell polarizes, with liberation of hydrogen at the carbon electrode. When the gas sample is passed through the carbon electrode, oxygen from the sample diffuses through the wall. This oxygen combines with the hydrogen, forming water, and causes depolarization. Consequently the greater the oxygen content of the sample, the higher the current output will be from the primary cell.

Thermal Conductivity Techniques

The hydrogen-difference method is a relative thermal-conductivity type. The gas sample to be analyzed is mixed with hydrogen and then its thermal conductivity is measured. This mixture is combusted in a chamber where the oxygen and hydrogen combine. Thus all the oxygen and equivalent hydrogen are removed. The remaining mixture is measured for thermal conductivity. Owing to the high thermal-conductivity of hydrogen, there is a difference between the two readings, depending on the amount of hydrogen which has combined with the oxygen in the gas sample.

Another method used to measure oxygen concentration requires the sample gas to be passed through a carbon furnace to convert the oxygen to carbon dioxide. Measurement is based upon the difference in the thermal conductivity of the gas before and after passing through the furnace.

Catalytic Combustion

The catalytic-combustion principle is utilized by some types of oxygen analyzers. In this method the flow of gas to be analyzed is controlled by passing it through regulating valves and a flow orifice. This metered gas sample is mixed with a measured amount of standard, vaporized fuel. This mixture is passed over a catalyst filament, where combustion takes place. The heat liberated from this combustion maintains the filament at a temperature proportional to the oxygen content of the sample. This filament forms one leg of an a-c. measuring bridge. The unbalance in this bridge is amplified and used to drive a motor-driven slidewire which maintains a continuous balance in the measuring circuit.

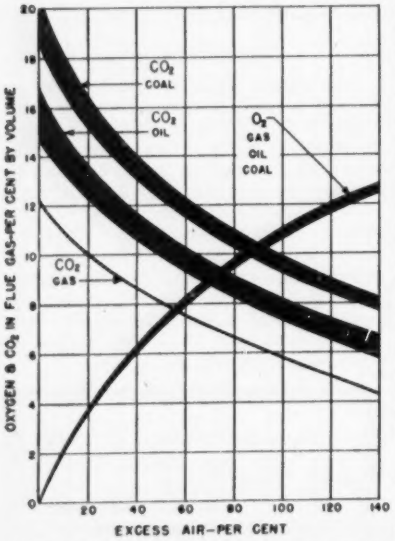

Fig. 2. Oxygen compared with carbon dioxide as an indication of excess air.

Paramagnetic-technique Analyzers

The last two types of oxygen analyzers to be discussed employ the paramagnetic property of oxygen as their measuring principle. Oxygen is unique among the common gases in that it is strongly attracted into a magnetic field. Other common gases, on the other hand, are repelled slightly from a magnetic field. These repulsion effects are so small that they may be ignored except when measuring full-scale oxygen concentrations in the order of 1 percent or less. In such special applications methods have been developed to compensate automatically for "background" effects of gases other than oxygen. In the great majority of applications no such compensation is necessary and a measurement of the paramagnetic properties of a sample gas can be accurately interpreted as a measurement of oxygen content.

Indirect Method

An indirect method of measuring the magnetic properties of oxygen is to utilize the change in its paramagnetic qualities associated with temperature variations. This is done in the following manner: The gas to be analyzed is allowed to diffuse into two measuring chambers, one of which is partially encircled by a strong permanent magnetic field. Both chambers contain an electrically heated resistor. These resistors are connected to a Wheatstone-bridge circuit so that the flow of current through each can be compared. Oxygen attracted into the magnetic field becomes heated by the hot-wire resistor and loses some of its magnetism. It then is forced out of the magnetic field by the cooler more-magnetic oxygen. Thus a flow of the sample gas is induced which cools the heated resistor. This, of course, changes its resistance and, consequently, the current flow through this resistor. This change is compared with the current flow in the other heated resistor which is not cooled by the gas convection of the oxygen in a magnetic field. The difference in current flow can be interpreted as oxygen concentration.

Direct Method

The most recent development in oxygen measurement is a method which directly measures the paramagnetic property of oxygen. As explained previously, all gases are either attracted into a magnetic field (paramagnetism) or are repelled out of a magnetic field (diamagnetism). Liquid and solid substances also possess these properties in varying degrees.

In illustrating the magnetic field by Faraday lines of force, the diamagnetic behavior could be described by assuming that diamagnetic bodies have less lines of force running through them than normally exist in the space occupied by them—that is, they have a permeability less than unity (which is ascribed to free space). These distorted lines of force tend to return to their normal state by forcing the diamagnetic substance out of the area of strongest flux density. For paramagnetic-body behavior the tendency is to have a greater number of lines of force running through them than would pass through the space which they occupy —that is, they have a permeability greater than unity (the value of free space). Therefore, a paramagnetic substance displaces out of a magnetic field another substance which possesses less paramagnetism. This is the principle that the Arnold O. Beckman Oxygen Analyzer uses for its method of measurement. This instrument (Fig. 3) employs a sensing element consisting of a small dumbbell-shaped body suspended in a permanent non-uniform magnetic field. This dumbbell is free to rotate and is subject to a magnetic force which is proportional to the difference in volume magnetic susceptibilities of the dumbbell and the gas which the dumbbell displaces. Thus the dumbbell will rotate out of the region of maximum flux density if it is surrounded by a gas which is more paramagnetic than the dumbbell. Conversely, if the sample gas is less paramagnetic than the dumbbell, the dumbbell will be drawn toward the region of maximum flux density.

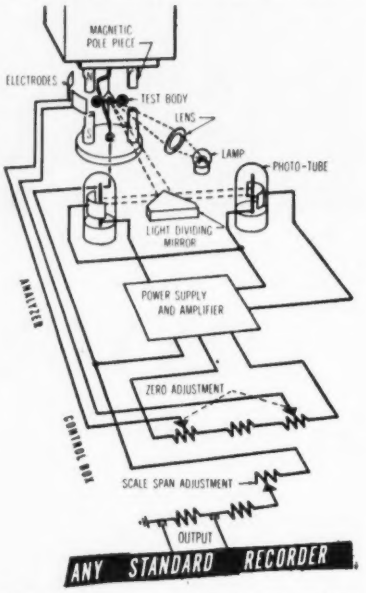

Fig. 3. Diagram of recording oxygen analyzer, null-balance type.

The dumbbell is a small light-weight element made of two hollow glass spheres supported, together with a small mirror, on a quartz fiber. The mirror reflects a narrow light beam which indicates the angular position of the assembly.

The sensing element is used in two similar types (Fig. 1) of oxygen-measuring measurements—the deflection type and the null-balance type. In the deflection-type instrument the dumbbell rotates to an equilibrium position where the magnetic rotational force is balanced by the torsional restoring force of the supporting quartz fiber. The beam of light reflected from the mirror is deflected in accordance with the rotation of the test body and indicates oxygen concentration by the position of a spot of light on a calibrated translucent scale. Accuracies to plus or minus 1 percent of full scale or better can be obtained.

In the null-balance type of instrument the dumbbell is restored to its null, or zero, position by the application of a force equal and opposite to the magnetic force produced by the gas sample. This is accomplished in the following manner: The glass dumbbell is metal-coated to make it conductive, and is connected to a variable source of electric potential. Near the

Fig. 4. Portable oxygen analyzer of manual null-balance type.

dumbbell are two electrodes maintained at fixed electric potentials and arranged in such a manner as to constitute, with the dumbbell, a heterostatic electrometer (Fig. 3). The potential required to hold the dumbbell in its null position is a direct measure of the oxygen concentration of the gas surrounding the dumbbell. In the analyzer shown in Fig. 4 the dumbbell is returned to a null position by manually varying the voltage between the test body and the two reference vanes. The dumbbell is at its null position when the narrow light beam reflected from the mirror is centered on the vertical engraved line on the translucent scale of the instrument. Oxygen concentration is read from the potentiometer dial used to vary the voltage. An instrument of this type can be made with single or multiple ranges which may be as narrow as 1 percent and which possess an accuracy of plus or minus 1 percent of full scale. This accuracy is assured by providing methods of standardization at two points within the linear range. Oxygen-free gas and dry air can be used for such periodic standardization. An extra range of 0 to 25 percent O_2 often is provided so that span adjustments can be made with dry air (20.93 percent O_2).

In some models (Fig. 3) the dumbbell and mirror assembly are automatically and continuously returned to the null position. This is accomplished in the following manner: The beam of light, which is reflected from the mirror attached to the dumbbell assembly, is normally equally divided between two photocells. When the dumbbell begins to rotate due to a change in the relative magnetic qualities of the dumbbell and the surrounding gas, there results an unbalance in the amount of light on the two photocells. This unbalance produces an electric current, which is amplified and used to rebalance the dumbbell to its null position by changing the potential on the surface of the dumbbell. This rebalance potential is measured and recorded on a standard potentiometer (Fig. 1). Thus, changes in oxygen concentration (partial pressure) are accurately translated into proportional voltage changes which can be recorded as a linear function on a standard potentiometer. This method embraces ranges from less than 1 percent full scale to ranges up to 100 percent full scale, as well as suppressed-zero ranges such as 16-21 percent or 90-100 percent O_2.

The instrument normally takes slightly less than one minute for a 95-percent response, but special "flow-through" models give this response in about five seconds.

Many of the low and suppressed-zero ranges maintain accuracy by automatic standardization with gases of known oxygen-content. An oxygen removal apparatus can be used for this purpose if it is advantageous to use the gas being analyzed as a standardizing gas.

The benefits of a direct measuring method such as this one include greater selectivity, accuracy, stability and variety of ranges.

Sampling

Regardless of the operating principle, all oxygen analyzers have minimum requirements as to sample gas conditions. Generally speaking, the gas sample must (1) be free of suspended solids and corrosives, (2) have all the condensables removed, (3) have proper flowrate and pressure regulation, and (4) be kept within certain temperature limitations. Pressure, flowrate, and temperature can be regulated by standard equipment; however, removing contaminating material from the gas sample often presents the major problem. Fig. 5 is an example of one of the more successful methods.

The sample is withdrawn through a sample tube, into an expansion chamber, through a pump, through a separator drain, then to a calibration and control cabinet and the analyzer. The sample tube consists of a small stainless or ceramic tube within a larger pipe. It is suspended only at the hot end so that the inside tube will tend to maintain its temperature throughout its entire length; this helps prevent any concentration of water or other chemical vapors, which could result in plugging. The gas sample is pulled into an expansion chamber, which is cooler and allows condensation to take place. This mixture of gas sample, water, and contaminants travels through the pump to the separator drain. The solids are kept in suspension by the condensed water. In dirty installations a small amount of water (approximately 30 cc. per minute) is added at the expansion chamber to facilitate this suspension.

Most of the solids and liquids are removed from the gas sample by the separator drain. In addition, the separator drain by-passes a large portion of the sample, while diverting a smaller amount to the analyzer. This decreases the time lag in the sample lines and provides a more responsive system.

In addition to the separator, a glass-wool filter (or other simple filter) and a "Flowrator" are used. The most commonly used components of a sampling system (the "Flowrator," the fine filter, and the sample and calibration valving) often are mounted together to form the calibration and control assembly (Fig. 5). If it becomes necessary to remove a sample tube from a process stream which is under pressure, an isolating valve and packing gland can be used.

Many types of accessory apparatus can be incorporated in oxygen-analysis systems—alarms, relays, automatic controls, etc. There seems to be no limit to the possible applications of oxygen-measuring instruments. Thus this type of equipment will continue to be one of the leaders in the ever-expanding instrumentation of industry, agriculture, medicine, and research.

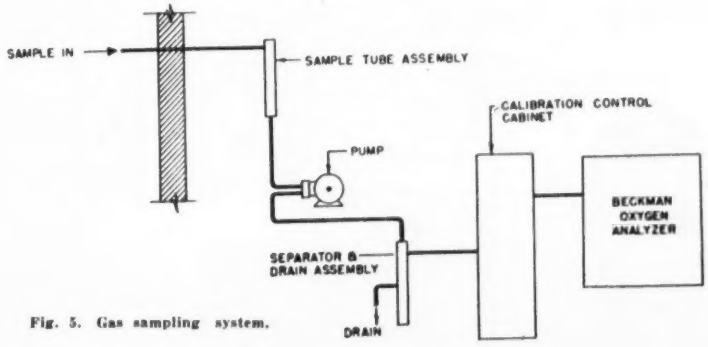

Fig. 5. Gas sampling system.

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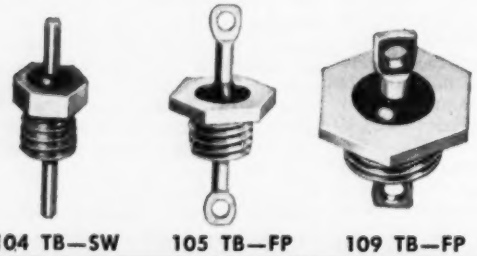

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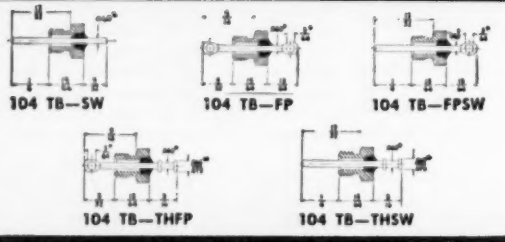

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104 TB—THFP 104 TB—THSW

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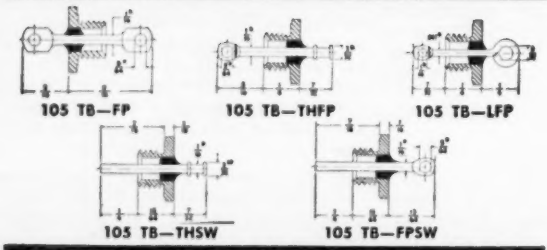

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105 TB—THSW 105 TB—FPSW

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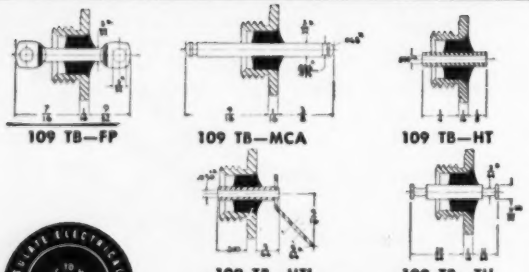

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ENGINEER'S NOTEBOOK

continued from page 1179

troller. With this system, the temperature recording-controller did not give a straight-line record for a given concentration. This changing temperature record proved confusing to the operators even though the product concentration was constant. They were constantly referring to the temperature-pressure charts to determine that the evaporator effluent concentration was correct. Additional confusion resulted when it was desired to change the evaporator operation to produce a different effluent concentration.

By a simple change in the existing instrumentation (Fig. 5) the recording temperature-controller was converted into a recording concentration-controller. This instrument

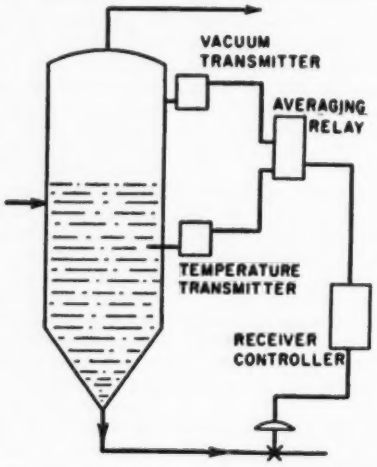


Fig. 5. Concentration control system.

gives a straight-line chart record for a given concentration, even though the evaporator pressure does change.

The pneumatic-set temperature controller was converted to a standard recording receiver-controller. The outputs from the pressure and temperature transmitters were fed into an averaging relay. The output of the relay in turn was fed to the recording receiver-controller. The ranges of both the pressure and temperature transmitters must be chosen properly so that the output of the averaging relay falls on the solution concentration curve.

Suppose, for example, the evaporator is operating on a solution which has a linear pressure-temperature relation for various concentrations (Fig. 6). The temperature transmitter has a 3-15-psi. air output over a range of 100-148 deg. Centigrade. The pressure transmitter has a 3-15-psi. air output over a range of 20-26 inches Hg. vacuum. The solution concentration range for the specified pressure and temperature ranges is 22 to 28 percent. Now, for any point on any particular concentration line, the sum of temperature and pressure transmitted-air-pressures divided by two is a constant. Thus the concentration recorder produces a

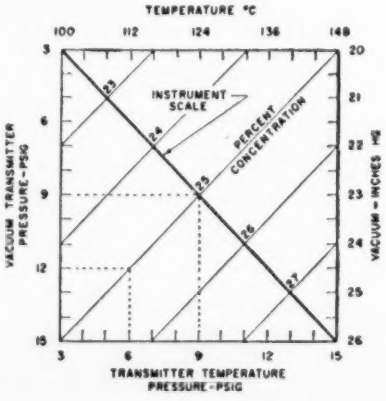


Fig. 6. Pressure-Temperature-Concentration chart.

straight line for any given concentration, regardless of temperature or pressure variations.

The calibration of the concentration recorder can be only an approximation for most solutions. This is because the pressure-temperature curves for various concentrations of solutions are not linear and do not have the same slope. However, for the narrow span generally required for such applications, the calibration can be made close. The changes made in this system, giving a straight-line control for a given concentration, have proved a great boon to the operators.

Self-Cleaning Antimony pH Electrode

Despite the recent advances made in the development and application of the glass electrode for pH measurements, there are still a number of applications for the antimony electrode. In solutions containing no oxidizing or reducing agents, the antimony electrode has advantages which merit serious consideration, especially at high pH levels. The measuring circuit is of fairly low impedance so that an ordinary potentiometer instrument without special insulation and shielding can be used. The readings obtained are reliable and reproducible so long as the surface of the antimony is continuously cleaned of the reaction products.

Various motor-driven cleaners for the commercial antimony electrode have been used. However, these cleaners require considerable maintenance. As the sample is almost always available under pressure, this pressure energy can be used to make the electrode self-cleaning, as shown in Fig. 7.

The electrode is an annular ring of antimony clamped between two machined discs of insulating material, forming a chamber or race in which an ordinary glass marble can circulate. The sample inlet is tangential to the chamber so that the force of the liquid causes the marble to rub along the surface of the antimony. The outlet from the chamber is in the center through a saran tee into which the KCl reservoir for the reference electrode is inserted.

Only a few feet of liquid head are required to furnish enough energy to cause the marble to keep the antimony surface clean. This assembly has proven so satisfactory that it has almost entirely replaced the motor-driven electrode cleaners.

The Little Man

Hand wheels and hand jacks sometimes are attached to control valves to prevent the valve from closing entirely. This provides a minimum opening of the valve at all times for safety or certain operating conditions. It is inconvenient and expensive to add hand jacks to control valves, particularly those with the positioner on top of the operator directly above the valve stem. For this application we made a pneumatic hand jack which our Operating Department refers to as "The Little Man," because it keeps a constant watch over the control valve.

The device was made from an inexpensive pressure regulator of the type used in instrument air supplies. The relief port of the regulator must be soldered closed so the

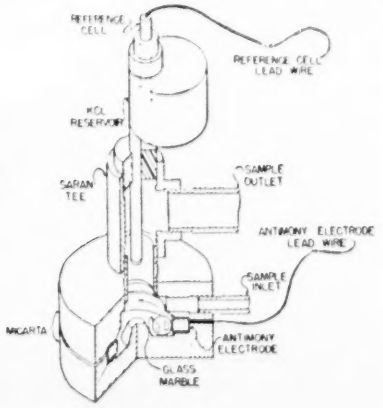
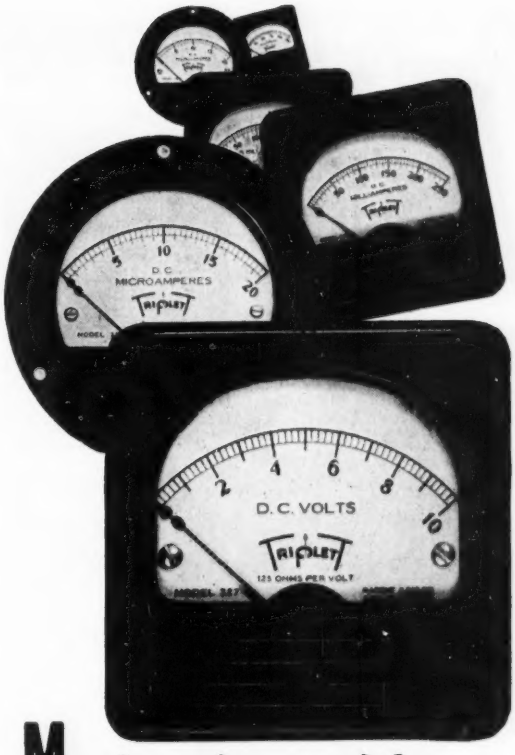


Fig. 7. Self-cleaning antimony pH electrode assembly.



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downstream pressure from the regulator cannot bleed back through it. In operation, the pneumatic hand jack is set to deliver (directly into the control air line to the valve) a pressure corresponding to the minimum opening desired on the control valve. If the output pressure from the controller falls below this set pressure, air will be supplied by the pneumatic hand jack. This air will also bleed back through the controller nozzle. As long as the output pressure from the controller is above the minimum set pressure, the valve operates normally and no air can bleed back through the plugged relief port of the hand jack regulator.

"The Little Man" has proved useful also in setting minimum control points on pneumatically-set instruments.

Conclusion

The Instrument Engineer's Notebook becomes full of notes and simple sketches which have proved useful in many applications. For example, in measurement or control which requires a dip pipe immersed in a liquid, false measurements frequently are caused by a build up of solids on the end of the dip pipe. This trouble is generally eliminated simply by using a Teflon nipple on the end of the pipe because the deposits formed on purged dip pipes will not stick to Teflon.

Also in the Notebook are found many mistakes made by the Instrument Engineer, from which he learns how a job should *not* be done. It is just as important for him to refer to these pages as to those containing the successful applications.

CONTROL SYSTEM ANALYSIS

continued from page 1181

about 15 feet above ground. The three-way air switch (SW_1) was mounted on top of the control valve.

Prior to starting the tests, records were obtained of the four variables listed above for a period of several hours. These data had no direct value in analyzing the system, but they provided a picture of typical load fluctuations which occur during normal operation. This also provided an opportunity to observe operation of the various components of the recording system and to determine the optimum sensitivity adjustments, chart speeds, etc.

Closed-loop Step-response Test

The closed-loop step-response tests were made by manually shifting the set point of the TRC above and below the control point (Fig. 4), first in small increments—in the order of 0.2 deg. F. The magnitude of the steps was then increased to plus or minus 0.5 deg. F., which was the maximum allowable. From the data recorded at P_1, P_2 and T_1 the amount of input pressure change to the diaphragm motor of the control valve required to produce a temperature change of 0.5 deg. F. was determined. With this information it was possible to make open-loop step-response tests with little danger of upsetting the plant.

First the FRC and the TRC were transferred to remote manual control in the control room. In order to approach

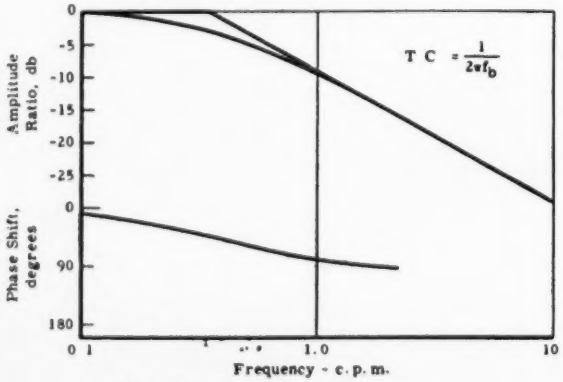

Fig. 8. Open-loop response of flow process.

a step-type input pressure change to the valve, the reducing valve on the sine-wave generator was used as the source for one pressure level, and the remote manual station of the FRC as the other. The input pressure was changed by turning the three-way switch SW_1. A man was required at each of three stations—the control board, the control valve where the three-way switch was located, and the recording equipment and sine-wave generator. Telephone communication was provided between the three members of the test group. With this arrangement the tests were made in a minimum of time and with little interference to plant operation.

Frequency-response Tests

The test set-up and procedures for making frequency-response tests were similar to those for the open-loop step-response tests. The sine-wave generator was first adjusted until its average value, or "d-c." level, was the same as the pressure on the diaphragm motor. The sine-wave amplitude then was adjusted to give temperature changes no greater than ½ deg. F. above and below the control point. The input pressure to the diaphragm motor was then transferred from remote control at the panel to the output of the sine-wave generator.

The test was started at the high end of the frequency range to be explored. There are good reasons for following this procedure, particularly when testing processes with comparatively long response times. There are several closed-loop control systems associated with the column, and there are other feed-back paths within the process. For example, the bottoms product exchanges heat with the feed to the column. The interaction effects from these systems tend to be more troublesome at the lower test frequencies; these disturbances of long periods are transmitted through the feed-back paths with little attenuation and are apt to distort the response records of the system under test and may upset other process control loops.

Fortunately it is not too important if frequency-response data cannot be obtained at the lower frequencies because

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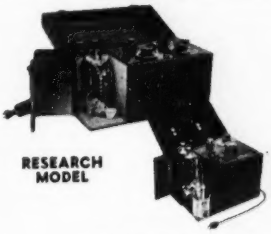

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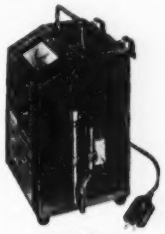

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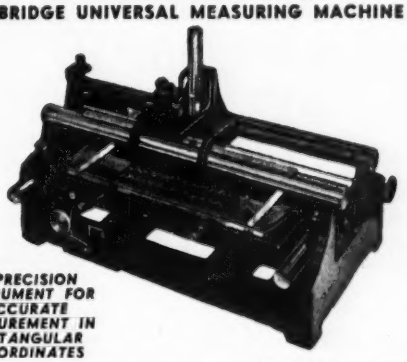

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the major time-constants, which appear in the low-frequency spectrum, can be determined within practical accuracies from step-response curves, as will be explained.

Another factor which may interfere with frequency-response tests is drift. For example, the temperature could be affected by changes in composition of feed, heat medium, temperature, flow rate, etc.

The time required for making a complete frequency-response test covering the desired range was approximately four hours. By following the procedure outlined, little trouble was experienced from drift or interference from extraneous sources. The tests in no way interfered with normal operations of the plant.

As will be explained, analysis of the data indicated that it might be desirable to relocate the sensing element of the temperature controller to a lower tray in the column. In order to find the optimum location, tests were made to determine the relative changes of temperature at equally spaced trays from the reboiler to the 14th tray in response to step changes in the flow rate of the heat medium. These open-loop tests provided a dynamic temperature profile which proved more useful from a control stand-point than the conventional static profile curves.

Tests Results

The values of the system parameters (Table 1) were determined from the step- and frequency-response diagrams. The technique for obtaining these parameters is described in the article by B. Stanton, "Instrument Evaluation by Frequency Response" in the May issue of the SCMA Journal (see *Instruments*, May, 1953, page 745)[3].

Table 1. System Parameters

	Prop. Band	Reset Rate	Time Constants	Time Dead	Open-loop Gain
TRC					
Before	20%	0.14 R/min.			
After	10%	0.50 R/min.			
FRC	50%	0.33 R/min.			
Temperature Process Before			2.26-0.86	0.4	1.0
Temperature Process by Step			2.26-0.72	0.3	1.0
Flow Process			0.45	0	2.89
Temperature Process After			2.26-0.11	0.4	1.0

Step Response of Temperature Process

The open-loop step-response curve of the temperature process is shown in Fig. 5. Note that there is no response to the step-input change for a short time. This is the dead time. The temperature then rises to its final value, forming an S-shaped curve.

The first knee of the curve, where the slope changes relatively fast with time, is due to the short time-constant (high frequency). The second knee of the curve, where the slope changes at a slower rate with time, is due to the large time-constant (low frequency). Note that the value of the major time-constant T_1 (2.26 minutes) is the same

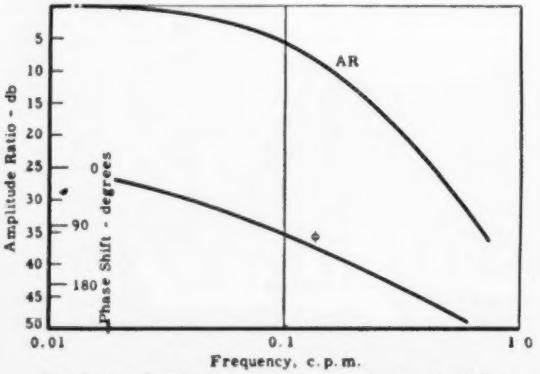

Fig. 9. Open-loop frequency response of column and reboiler.

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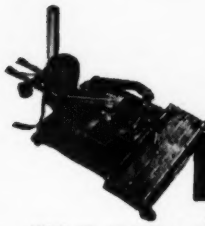

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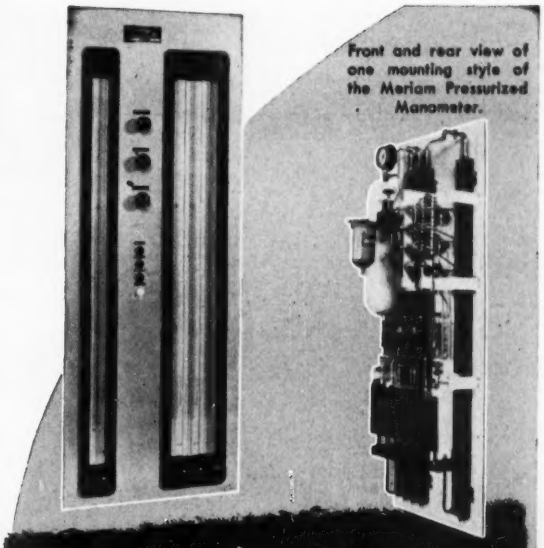

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as that determined from the frequency-response data (Table 1). From the step-response data, the proportional gain (output divided by input) was determined for both the flow process and the temperature process, as shown in the last column in Table 1.

Frequency Response of Flow Process

The frequency-response data are input and output records (Fig. 6). Note that as the frequency increases, the amplitude of the output may rise before it decreases. Fig. 7 illustrates the method for determining the amplitude ratio and the phase shift for each frequency from the input and output records. From these data two curves are plotted —frequency vs. amplitude ratio and frequency vs. phase shift. These are referred to as Bode diagrams.[7, 8, 9, 10]

The results of the frequency-response tests of the flow process are shown in Fig. 8. From the characteristics of the amplitude-ratio curve and the associated phase shift, there appears to be a single time-constant of 0.45 minute, which was determined to be due to the damped mercury manometer of the flow transmitter. The lags of the transmission lines and the control valve are insignificant in comparison to that of the manometer and are not apparent at the test frequencies. The adjustments of the controller functions were 0.33 repeat-per-minute reset rate and 50-percent proportional band (gain of 2.0).

Comparison of the time constants of the flow process (0.45 minute) and the temperature process (2.26 minutes) shows that the flow process responds much faster. However, as the flow-control system is the slave of the temperature controller, its response time should be negligible compared to that of the temperature process. Therefore the mercury manometer was replaced with a diaphragm-type differential-pressure transmitter. As a further improvement, a high-capacity-type valve positioner was installed on the diaphragm control valve. As the lags of the transmission lines were insignificant there was no justification for local mounting of the controller.

Frequency Response of Temperature Process

The frequency-response curves of the temperature process are shown in Fig. 9. The process has a gain of 1.0 and is composed of two time-constants—2.26 and 0.86 minutes—and a dead-time lag of 0.4 minute. The time constants appear to be (1) the time constant of the reboiler and column up to the thermowell and (2) the time constant of the thermowell and resistance bulb. The dead time is believed to be the transportation lag of the flow of vapors from the reboiler up to the control tray. The thermowell and resistance-thermometer time constant checked closely with laboratory tests of similar equipment. The adjustments of the temperature controller were 0.14 repeat-per-minute reset rate and 20-percent proportional band.

Experience had shown that with these temperature controller adjustments the system was stable under normal operating conditions. However, with upsets of large magnitude the system tended to be unstable. Specifically, it was noticed that continuous cycling occurred at reduced heat-medium flow rates. One factor contributing to this char-

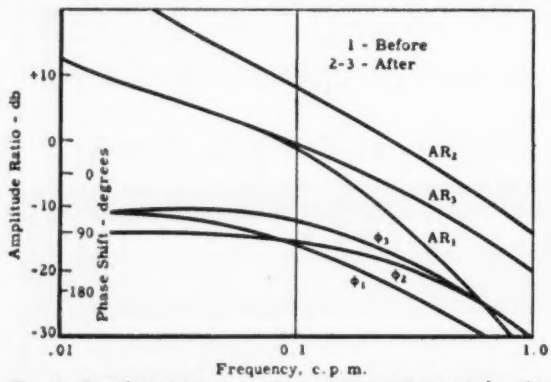

Fig. 10. Open-loop frequency-response of temperature-control system, before and after changes.

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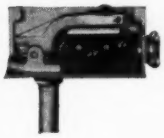

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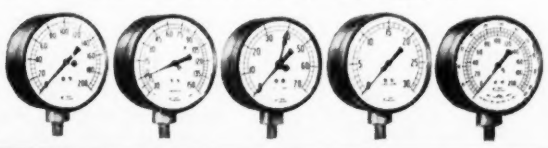

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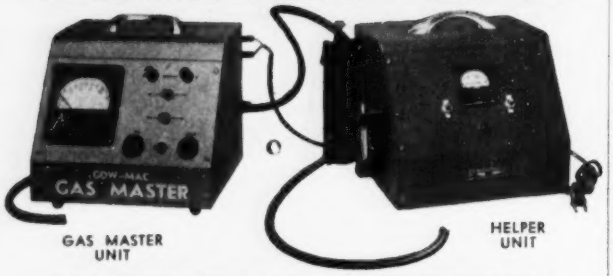

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acteristic was mathematically determined and will be explained.

The primary objectives were (1) to increase the speed of response of the system to set-point changes and (2) to improve the stability. The response speed can be increased by reducing the time constants; the improvement of stability without decreasing speed of response lies essentially in reducing the phase lag. In this situation the large time-constant and the dead time (which is a major cause of phase shift) were within the process.

It was thought that both the time constant and dead time could be reduced by relocating the temperature-sensing element on a tray nearer the reboiler outlet. To investigate this possibility, the dynamic temperature profile tests referred to previously were made to find the temperature-response characteristics of the various trays in the bottom section of the column. These step-response tests produced some interesting data. The temperature change at the reboiler outlet and on the first tray, and from the 12th to the 14th trays was of the same order of magnitude. From the 2nd tray to the 5th tray there was an initial change of temperature in an inverse direction. From the 6th tray to the 12th tray little temperature change could be detected. From these data it was considered advisable not to relocate the point of temperature measurement at that time.

It was considered possible and practical to reduce the time constant of the temperature-sensing element by use of a pneumatic temperature transmitter with derivative response. The derivative time-constant would in effect compensate for the thermowell time-constant. Laboratory investigation indicated that the 0.86-minute time-constant could be reduced to 0.1 minute. This means that the temperature-sensing element could then follow temperature changes at a faster rate. As a consequence the process becomes easier to control.

After the desirable alterations to the process control equipment were determined the controller adjustments were investigated. It was found that the proportional band could be decreased from 20 percent (gain of 5) to 10 percent (gain of 10) and the reset rate increased from 0.14 repeat per minute to 0.5 repeat per minute.

Open-loop Frequency Response of Complete Temperature System

Fig. 10 shows open-loop frequency-response curves of the complete temperature control system. Curve 1 is the response of the system before making any alterations. Curve 3 shows the improvement that can be made by reducing the time constant of the temperature-measuring element, with the controller adjustments unchanged. Curve 2 is the response with the controller's proportional band set at 10 percent and the reset rate at 0.5 repeat per minute. It will be noted in curves 2 and 3 that the gain remains above the 0-db. (gain of 1) level and that the 180-degree phase-shift point appears at a higher frequency than in the curve representing the unimproved system. This produces an increase in frequency band-width which represents an increase in speed

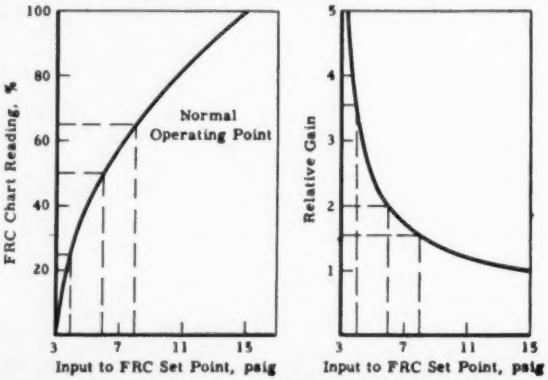

Fig. 11. Change of gain in temperature-control loop due to square-root flow characteristic.

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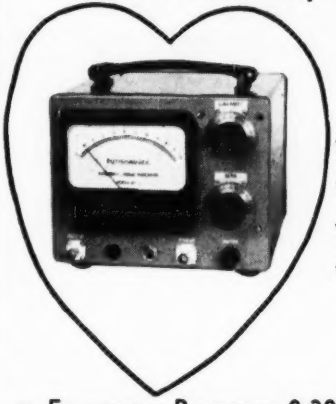

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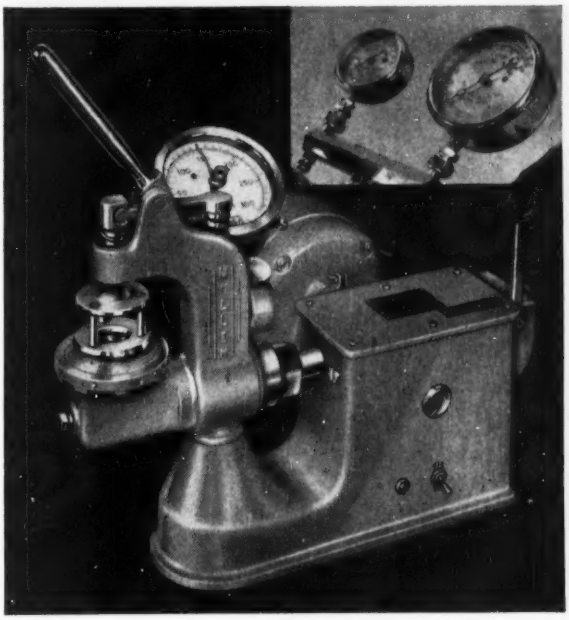

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of response of the control system. Transient recovery curves following step upsets now show faster recovery than that obtained with the original system.

The conventional type of rate action would be of little value in this application because of the amount of dead time, which increases phase lag without decreasing the gain. To compensate for this, a rate unit giving a large phase advance but low gain is required. In most rate units an increase in gain is inherent with phase advance.

It should be emphasized that the curves in Fig. 10 represent the temperature control system when the heat-medium flow rate was at its normal value, which was about 6.5 on the flow chart. It can be seen in Fig. 11 that if the heat-medium flow is reduced, the gain of the temperature control system is increased. This is due to the square-root relationship between air-pressure input to the FRC set-point mechanism and the resulting flow changes.

Conclusions

It has been shown that step-response and frequency-response tests can be made without seriously disturbing operating plants. At present the tests are comparatively time consuming and involve considerable effort and expense. However, it is only by gaining practical experience that improved techniques and equipment can be developed.

The tests provide data which allows practical application of frequency-response methods for solving process-control problems. Perhaps of more importance, the information provides a better understanding of the behavior of control loops when operating as an integral part of an overall complex system. The benefits lie not only in the development of process equipment with improved response characteristics but also in the design of better control-system circuitry.

Acknowledgement

The authors wish to express appreciation to the Shell Oil Company, Wood River, Illinois Refinery for providing the opportunity for making the test. Particular thanks are due to Mr. A. J. Woods and members of his operating department for their cooperation and helpful suggestions, and to Mr. W. E. Boyle and his staff for their help in conducting the tests. Special mention is due also the following members of the Shell Development staff: Mr. G. Lindsey for his able assistance in conducting the tests; Messrs. E. G. Holzmann, P. E. A Cowley, W. J. Deissinger and A. Bremer for their contributions in the analysis and presentation of the data.

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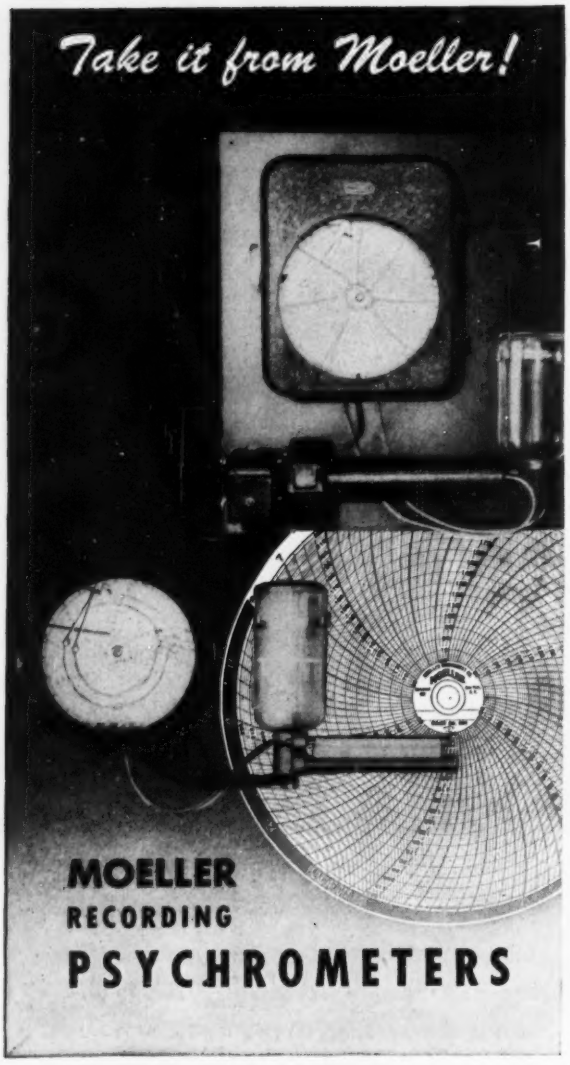

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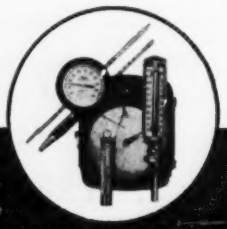

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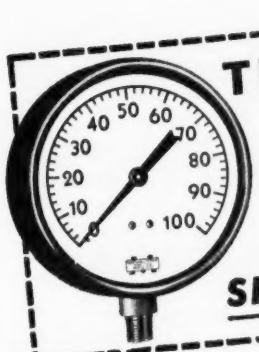

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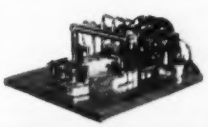

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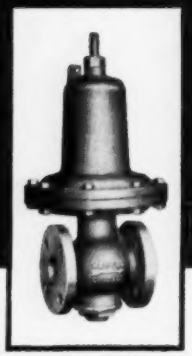

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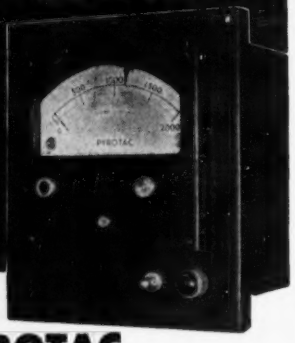

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PROCESS CONTROL

continued from page 1185

As for integral action, it depends on the time constant of the system. Derivative action will, however, increase as the time constant increases.

Derivative action is defined as the time R taken to increase the proportional action contribution to controller output by an amount equal to the derivative action contribution when the deviation θ is changing at a constant rate.

To find the relation between ρ and μ, suppose the pen of the recorder/controller with proportional and derivative actions starts to move at constant rate across the chart, so that after a time R it has moved a distance θ. Immediately this change commenced, the derivative action would have produced a potential correction (Θ_D) proportional to the rate of change of θ, and equal to $\rho d\theta/dt$. If R is the time required for the proportional action to produce a potential correction (Θ_P) equal to the derivative action, clearly we must have

$$\Theta_D = \Theta_P$$
$$\rho\, d\theta/dt = \mu\, \theta$$

But
$$d\theta/dt = \theta/R$$

Therefore, $\rho = \mu R$. (See equation 6 of chapter 7 for the complete controller equation.)

The value of the derivative time R is normally varied by changing the restrictor resistance; the effect of the derivative action increases as the restrictor resistance increases.

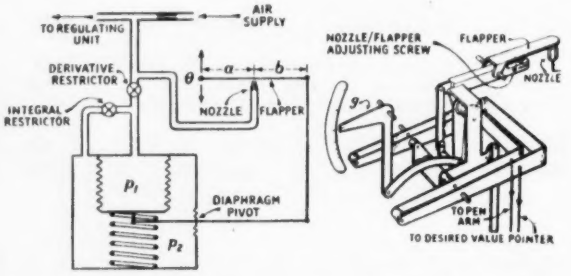

Fig. 8-9. Typical controller mechanism for proportional plus integral plus derivative actions. The control relay (Fig. 8-2) is not shown for simplicity—but would be placed immediately above the derivative restrictor at the entrance to the bellows unit. Note that the single bellows unit provides the three basic control actions. If the derivative restrictor were opened completely, and the integral restrictor closed, the bellows unit provides proportional control only.

Proportional Plus Integral Plus Derivative Action

It is sometimes necessary to use the three actions in one controller (although not as frequently as current practice indicates). A number of different methods of generating and combining the three actions are in use. The integral action usually is based on a restrictor plus capacity, and the derivative action on a restrictor between the output pressure and the "feed-back" bellows.

The methods of combining the actions determine the basic characteristics of the controller. Many proprietary designs of pneumatic controllers have the derivative and integral actions arranged either in "parallel" or in "series." It is profitable to select controllers on the basis of reliability, ease of setting up, adjustment, maintenance, robustness, and cost. Under ease of adjustment is included the provision of calibrated dials for setting integral and derivative action times, and restrictors which will ensure that these times are reproducible.

Effect of Using Both Derivative and Integral Actions

When integral and derivative actions are both incorporated with proportional action, the generating systems interact in all the controllers used widely at present. The interaction, produced because the same bellows is used to obtain the derivative and integral actions, causes the action times generated to differ from those marked on the dials.

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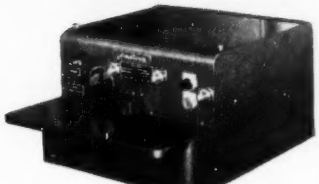
Plus Many Others



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A great aid to your miniaturization program

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MOUNT IN 15/32" HOLE
ALL LENS COLORS

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Complete blackout or semi-blackout dimmer types

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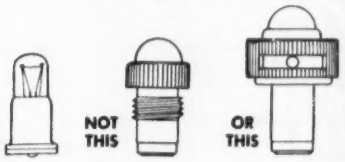
THESE ASSEMBLIES LOGICALLY REPLACE LAMPS NO. 319, 320, and 321



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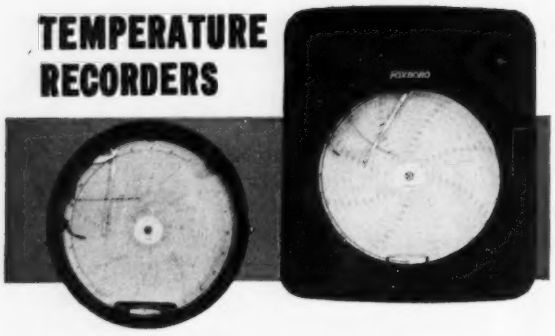

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to avoid lost profits

Accurate Foxboro Temperature Recorders give you a minute-by-minute report of process conditions — an invaluable aid in determining future operation. Moreover, the records forecast impending difficulties — permitting corrections to be made before costly trouble starts.

Available with vapor pressure, gas pressure, or liquid expansion type systems. Choice of 50 standard bulbs; 700 chart ranges and scales from −450° to +1000°F. Round or rectangular cases for all operating conditions. Exclusive Foxboro design and construction advantages detailed in Bulletin 447. (Temperature indicators and controllers also available.) Write **The Foxboro Company, 46b Norfolk St., Foxboro, Mass.**

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For more information circle 150 on inquiry card.

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For more information circle 151 on inquiry card.

Also, it will be found that the proportional-control factor has apparently increased if the controller is used first without either integral or derivative actions, and then with both. (This increase is independent of period and must not be confused with the increase in "gain" due to the integral and derivative actions.

The change in the effective proportional-control factor is important. If not appreciated, it may be difficult to bring a plant under satisfactory control when all three actions are used. Increase of derivative action may well cause such a large increase in the proportional control factor (i.e., narrow the band-width so much) that the system will become unstable and go into violent oscillation. It is possible to increase the effective value of μ by a factor of 3 or more by changing the ratio R/S by, say, 2. This is not by any means an unlikely change to make in the integral plus derivative dial settings when a controller is being put into commission.

The interaction of the actions which results in a change of the integral and derivative times is of practical as well as theoretical interest. In particular it limits the ratio of the values of the integral and derivative times which can be obtained. Therefore the amount of derivative action, and hence the valuable phase advance, obtainable is limited.

The interaction produces "effective action" times (R and S) which differ from the "nominal" times (r and s) actually set on the calibrated dials. For the controller of the type shown in Fig. 8-9, it can be shown that

$$R = r/(1 + 2\ r/s)$$

and

$$S = s\ (1 + 2\ r/s)$$

The factor $(1 + 2\ r/s)$ is called the interaction factor.

Consequences of Interaction

(1) In some control problems it is necessary to use the three actions together and to employ the maximum amount of derivative action in order to obtain maximum phase advance from the controller and so work at the shortest operating period. The effect of interaction between the actions is to limit the maximum derivative action which can be *obtained* from the controller. This can be seen as follows, taking as an example the controller whose performance is defined by the equations above.

From these equations:

$$R/S = [r/s][1/(1 + 2\ r/s]^2$$

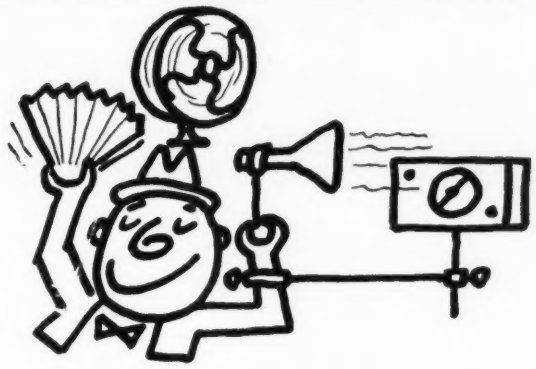
This expression has maximum value when $r/s = \frac{1}{2}$, or $R/S = \frac{1}{8}$. Thus the *effective* derivative-action time can never be more than one eighth of the effective integral-action time, which itself is often set equal to the plant period.

(2) The interaction factor also increases the proportional-action factor. Allowance must be made for this increase when adjusting a controller, or instability may result. For example, if $r = s/2$, the factor is 2; the effective proportional band-width will be halved.

Again, if an adustment is made subsequently to the derivative time, so that $r = s$, the effective band-width would be only one-third of the set width. This change in band-width might lead to instability in the control system, although not materially changing R/S. It is, therefore, important to be aware of this effect when setting up a three-action controller.

(3) Another implication of interaction is that any change in action times from their nominal values during operation, not only leads to a change in both action times, but also in effective proportional band-width. Such changes occur because the restrictors alter their resistance owing to mechanical changes or entry of dirt.

Note that the interaction factor depends on the arrangement for the addition of the output of the proportional, integral, and derivative units; therefore, each arrangement leads to a different interaction factor. The factor $(1 + 2\ r/s)$ applies only to controllers using the basic arrangement shown in Fig. 8-9.



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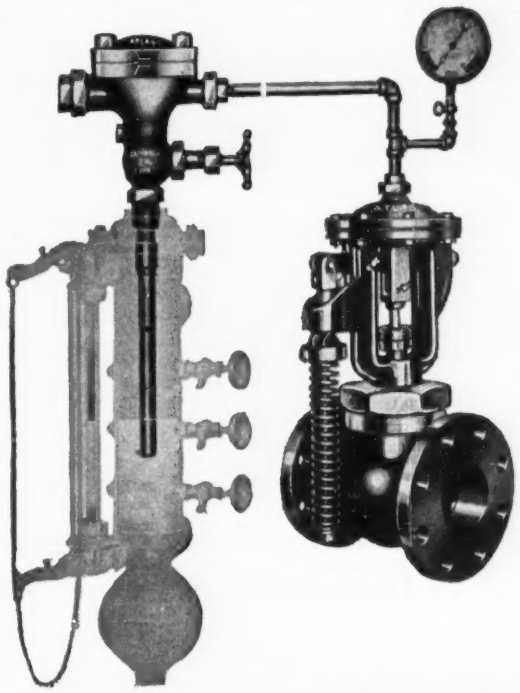

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Boiler Feed Water Regulator

1—Continuous Blowdown;
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The above are six of the principal reasons why operating engineers prefer the CAMPBELL Boiler Feed Regulator. All of those reasons are exclusively CAMPBELL features. Point No. 1—Continuous Blowdown—is an outstanding reason why the CAMPBELL is so well liked wherever used.

For many years the CAMPBELL has been successfully controlling all types and sizes of boilers. The slightest change in water level causes the regulator to operate the largest control valves instantly. Rugged. Efficient. Economical. No fine adjustments. 50 to 400 lb. pressure. Sizes 1" to 6". Guaranteed. Easily installed by any competent mechanic.

The Indicating Gage

The CAMPBELL also includes a Pressure Indicating Gage (shown above)—another exclusive feature. This gage can be placed on your switchboard or control board, to show precisely what the CAMPBELL is doing at all times.

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Exhaust Control Systems	Pump Governors	

For more information circle 154 on inquiry card.

INSTRUMENTS ON THE MARCH

New Principles, Applications, Non-commercial Developments

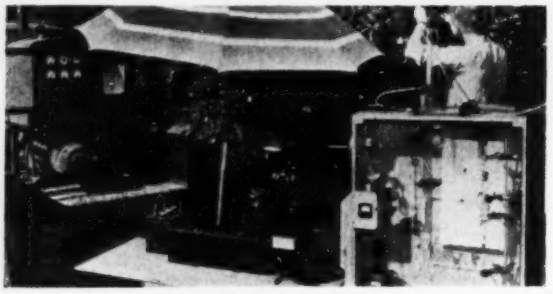
400-Mc. Transistors

STATE COLLEGE, PA.—Development of experimental point-contact transistors which oscillate at the highest frequencies known for transistor operation—above 400 megacycles per second—was reported by the Tube Department of the RCA Victor Division, RCA, Harrison, N. J., before the joint IRE-AIEE Conference on Transistor Research at Pa. State College.

RCA's experiments with developmental *p*-type point-contact transistors indicate that they are capable of oscillating at a substantially higher frequency than *n* types.

Insecticide Safety

RIVERSIDE, CALIF.—A Quartz Spectrophotometer is used by the Citrus Experiment Station of the U. of Calif. to study the contamination of grove environment and the pos-



sible hazard to citrus pickers. Over a 6-month period, no more than 0.05 mg. of parathion insecticide vapor per cubic meter of air was found in any grove tested, reassuring both field hands and residents of the area. The account of the study is available in Data File BB-10-47, Beckman Instruments, Inc., S. Pasadena 1, Calif.

Tunnel Safety

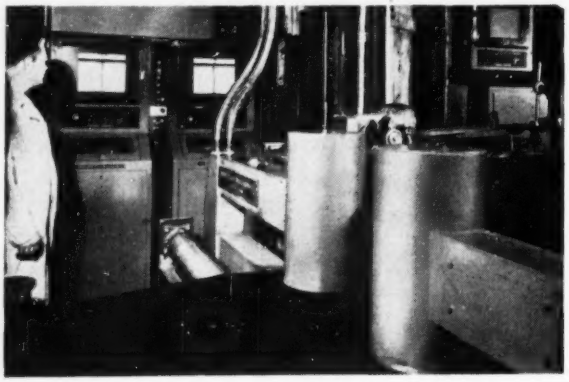
SEATTLE, WASH.—Automatic carbon-monoxide analyzers will protect motorists and control ventilation in the new 6-block Battery Street Subway in Seattle. The 144 ventilating fans are controlled by the analyzers. In addition, recording potentiometers will record concentrations at all times. The carbon-monoxide recorders and analyzers are made by Mine Safety Appliances Co., Pittsburgh, Pa.

X-ray Diffraction School

MT. VERNON, N. Y.—The North American Philips Co., Mt. Vernon, N. Y. announces advance registration for their free 5-day courses to be held in October, 1953 and in April 1954. Two days will be devoted to lectures, laboratory work, and question sessions; three days to diffraction applications, including specimen preparation, film diffraction and powder cameras, Geiger-counter X-ray Spectrometry, and X-ray Spectrography (fluorescence analysis).

Rubber Coating Control

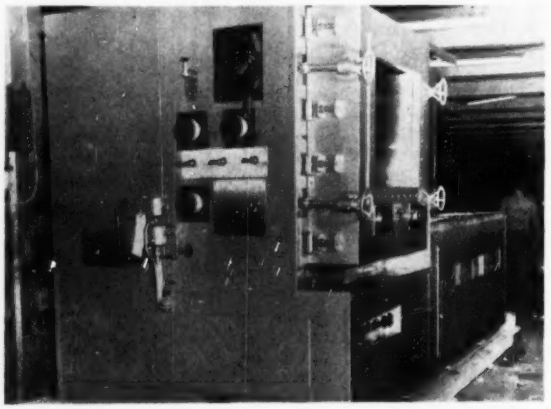
DENVER, COLO.—Radiation from an atomic by-product (Strontium-90) measures the thickness of the rubber coating applied to fabric at the Gates Rubber Company in Denver,



Colorado. The "AccuRay" beta gauge shown above is manufactured by the Industrial Nucleonics Corporation of Columbus, Ohio and provides the sensitive measurements which activate a new, fully automatic control system, now being used in rubber-product manufacturing at Gates.

Environmental Testing

DALLAS, TEXAS.—The Collins Radio Co. announces that special environmental testing equipment is being constructed by Bowser Technical Refrigeration, Terryville, Conn., for



testing aircraft equipment under simulated flight conditions. Two hand holes, equipped with rubber gloves, permit equipment under test at sea-level pressure to be moved and examined without disturbing test conditions.

New Product Announcement

Swartwout Autronic Type D2T Differential Pressure or Flow Transmitter

Differential Pressure Transmitter for static pressures to 5000 psig

Swartwout Type D2T transmitter is designed for use with other units of the all-electronic Swartwout Autronic Control System, the system that solves your toughest problems in remote control and/or recording of process variables.

CONDENSED SPECIFICATION DATA

MAX. WORKING PRESSURE: 1500 and 5000 psi models with full over-range protection.
BODY MATERIAL: 303 stainless steel.
DIAPHRAGM MATERIAL: 302 stainless steel or Teflon coated glass fabric. (Other body and diaphragm materials available to special order.)
RANGE: 0-20 to 0-200 inches water. Span continuously adjustable.
ZERO ADJUSTMENT: Vernier screw with lock.
COARSE SPAN ADJUSTMENT: Linkage ratio.
VERNIER SPAN ADJUSTMENT: Electrical; does not affect zero setting.
DISPLACEMENT: Less than 0.3 cc.
ACCURACY: ½%.
ULTIMATE SENSITIVITY: Better than .005%.
CALIBRATION: May be weight calibrated without removing from line.
REPRODUCIBILITY: 0.1%.
FREQUENCY RESPONSE: Flat to 8 cycles/sec.
SPEED OF RESPONSE: .02 seconds for 63.2% of full scale change.
AMBIENT TEMPERATURE EFFECT: 1% max. zero shift for 100°F temperature change.
STATIC PRESSURE EFFECT: Less than .05% per 100 psi change at 200" water span setting.
OVER-RANGE EFFECT: Less than 1% at 200" water span setting for full rated static over-range.
MAX. AMBIENT TEMPERATURE: 180°F.
CASE: Dustproof and weatherproof.
EXPLOSION PROOFING: Available. May be calibrated while in operation.

Investigate the advantages of the Swartwout Autronic System today. Literature and prices on request to factory or from Swartwout representatives in principal cities.

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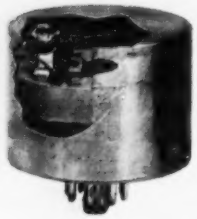
For more information circle 155 on inquiry card.

Plug In Meter-Relay



Hermetically Sealed & Shock Mounted. Model 265 non-indicating meter-relay has balanced movement, locking contacts, 0.2 microamperes sensitivity and sealed case.

Sensitivity Ranges

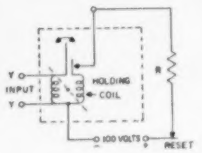
0.2 microamperes to 50 amperes, or .05 millivolts to 500 volts. The range can be changed with shunts or series resistors.

Accuracy

Factory adjustment within 3% of the specified current or voltage for most units. By adjusting circuit resistance the accuracy can be improved to better than 1%.

Contacts

S.P.S.T. or S.P.D.T. rated 5 to 25 milliamperes D.C. at 75 to 125 volts. Contacts lock in by a holding coil in the relay. They are released by breaking the circuit to the holding coil. The diagram shows internal wiring arrangement and basic circuit requirements. Load resistance R limits contact current to rated value.



Speed

Design variations allow for a range of response time from 1 millisecond to 10 seconds for most ranges. Time delay can be calibrated in seconds.

Case Style

Round metal can, sealed. Octal plug connector or other type of sealed header is optional. Rubber shock mount protects the jeweled movement from jars and vibration. Size: 2¼" dia. x 2¼".

A.C., D.C., R.F., F°, C°

The Model 265 used with copper oxide or crystal diode rectifiers works well on A. C. Rectifiers may be built in, likewise R. F. thermocouples. Calibrated in millivolts and with bimetal compensation this relay gives accurate control or safety alarm when used with temperature thermocouples. For further specifications write or call Bradley Thompson, Assembly Products, Inc., Chagrin Falls 75, Ohio. Phone CH 7-7374.

For more information circle **156** on inquiry card.

MANUFACTURERS' NEW LITERATURE

In this department we report new literature, pertaining to instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on Page 1253.

Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

PROCESS CONTROL

Pneumatic Control Accessories. New 20-page illustrated Catalog 8950 presents maker's line of pneumatic panels, switches, relays, valve positioners, air filters, etc. Includes principles, operation, typical applications. —Minneapolis-Honeywell Regulator Co., Industrial Div., Phila. 44, Pa.

Circle **401** on inquiry card.

Process Instrumentation. New 40-page Second-Quarter issue of "Instrumentation" has articles on strain gages, thermocouples, diaphragm valves, and how one large refinery keeps 36,000 instruments in operation. —Minneapolis-Honeywell Reg. Co., Industrial Div., Phila. 44, Pa.

Circle **402** on inquiry card.

Open-hearth Controller. New 8-page Bulletin DS-643-33NS describes and illustrates maker's combined temperature recorder and temperature-difference controller for automatic open-hearth reversal.—Leeds & Northrup Co., 4907 Stenton Ave., Phila., Pa.

Circle **403** on inquiry card.

Process Instrumentation. New 32-page illustrated issue Vol. 11, No. 3 of "Meters and Controls" presents articles on use of electric eyes in process flows, fuel feed compensation in heating problems, instrument and control application guide for flow, and problems in automatic combustion control. Includes 8-page section of capacity tables from "Penn's Flow Meter Handbook."—Meters and Controls Inc., 444 N. LaSalle St., Chicago, Ill.

Circle **404** on inquiry card.

Process Control. New 12-page illustrated edition Vol. 13, No. 1 of "Modern Precision" presents maker's controllers, analyzers, and recorders in use in research, testing, process and power industries. Also article on use of resistance-thermometer bridge.—Leeds & Northrup Co., 4907 Stenton Ave., Phila., Pa.

Circle **405** on inquiry card.

Unattended Pipeline Station Control System. New 6-page illustrated Data Sheet 781-3 presents description of automatic system controlling operation of unattended pumping stations for transmitting crude or product.—Foxboro Co., Foxboro, Mass.

Circle **406** on inquiry card.

Annunciator Systems. New 44-page illustrated Bulletin 100 presents features, specifications, applications, and engineering and National Electric Code Requirements for maker's hermetically sealed annunciator systems for process monitoring.—Panalarm Products, Inc., 6312 N. Broadway, Chicago, Ill.

Circle **407** on inquiry card.

Boiler-water Level Control. New 8-page Folder J-101 presents features, types, and typical users of maker's "Magnetrol" boiler-water level controls.—Magnetrol, Inc., 2110 S. Marshall Blvd., Chicago, Ill.

Circle **408** on inquiry card.

Linear Actuator. New 4-page illustrated Bulletin F 4381-1 presents design features, applications, and specification data for Linear Actuators used in remote positioning of aircraft engine controls, valves, etc. where linear motion is required.—Barber-Colman Co., Rockford, Ill.

Circle **409** on inquiry card.

Heater Control. New 2-page Instrumentation Data Sheet 3.4-10 describes maker's "Electronik" control system for a "Ste-Vac" heater.—Sta. 64, Minneapolis Honeywell Regulator Co., Phila. 44, Pa.

Circle **410** on inquiry card.

Refrigeration Controls. New 4-page Bulletin 109 gives specifications and engineering details on maker's refrigeration controls.—Partlow Corp., New Hartford, N. Y.

Circle **411** on inquiry card.

Instrumentation Magazine Index. New 8-page Bulletin 200-B presents complete alphabetical index of **Instrumentation** Magazine since 1943, listing all articles according to subject, and companies and institutions covered.—Minneapolis-Honeywell Regulator Co., Sta. 64, Industrial Div., Phila. 44, Pa.

Circle **412** on inquiry card.

TEMPERATURE

Temperature, Pressure. New 12-page illustrated Catalog Form 153 presents maker's line of indicating, recording, and control instruments for temperature and pressure. Includes mercury-actuated, vapor-actuated, air-operated, and self-operating types.—Century Instrument Co., 565 E. Milwaukee, Detroit, Mich.

Circle **413** on inquiry card.

Thermometers. Three new 4-page bulletins describe and illustrate

maker's thermometers for rubber and plastics industry, for refrigeration, and for paint and varnish.—Moeller Instrument Co., Richmond Hill 18, New York, N. Y.

Circle 414 on inquiry card.

Thermometers. New 4-page illustrated Bulletin 3 gives features and prices of maker's line of stainless-steel thermometers of fluid and expansion types.—W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys. Calif.

Circle 415 on inquiry card.

Freeze-drying Equipment. New 16-page illustrated Catalog 740 presents latest information on freeze-drying methods plus maker's line of freeze-drying equipment. Also described are vacuum pumps and vacuum gages.—F. J. Stokes Machine Co., 5500 Tabor Rd., Phila., Pa.

Circle 416 on inquiry card.

PRESSURE

Pressure, Vacuum Gages. New 32-page illustrated Catalog 7001 presents many types of pressure and vacuum gages used to measure vacuums from 10^{-11} mm. mercury and pressures to 150,000 psi. Covers principles, ranges, indicators, recorders, pneumatic and electric controllers and pneumatic transmission.—Minneapolis-Honeywell Regulator Co., Sta. 64, Industrial Div., Phila. 44, Pa.

Circle 417 on inquiry card.

Pressure, Vacuum Control. New 28-page bulletin describes and illustrates maker's cartesian manostats, absolute and differential manometers, and flowmeters, plus articles on theory and design of cartesian manostats.—Emil Greiner Co., 20-26 N. Moore St., New York, N. Y.

Circle 418 on inquiry card.

Pressure Transducer. New 2-page Bulletin 3.5 describes and illustrates maker's "Model P97" pressure transducer, for pressures of 0-0.05 psi. and with 0.1-percent resolution from minus 65 to plus 250 deg. F.—Statham Laboratories, Inc., 12401 W. Olympic Blvd., Los Angeles, Calif.

Circle 419 on inquiry card.

Pressure Probe. New illustrated Broadside presents features and performance of maker's "Sphere-Static Probe" for measurement of static pressure in air stream where flow direction fluctuates.—Flow Corp., 56 Kirkland St., Cambridge, Mass.

Circle 420 on inquiry card.

Pressure Switch. New 2-page bulletin describes and illustrates maker's "Series 100" multi-range pressure switch.—Alloy Bellows Engineering Co., Switch Div., 18125 Roseland Rd., Cleveland, Ohio.

Circle 421 on inquiry card.

Vacuum Impregnation. New 24-page Brochure 760 describes and illustrates applications of process by which voids in porous materials are filled with a desired impregnant after air and moisture have been evacuated.—F. J. Stokes Machine Co., 5500 Tabor Rd., Phila., Pa.

Circle 422 on inquiry card.

FLOW

Corrosive-Service Flow Meters. New 14-page illustrated Catalog 32 presents features, operation, and specifications for maker's large line of "Flowrator" variable-area meters for corrosive service. Includes procelain meters and valves, hard-lead meters, rubber-lined meters, etc.—Fischer & Porter Co., Hatboro, Pa.

Circle 423 on inquiry card.

Gas Flow Meter. New 4-page illustrated Bulletin 153 presents features, application, and engineering principles of maker's new "Vol-O-Flo" meter for accurate gas flow measurement.—National Instrument Laboratories, Inc., 6108 Rhode Island Ave., Riverdale, Md.

Circle 424 on inquiry card.

Orifice Flow Measurement. New illustrated data sheet D-1 5M presents features and dimensions of maker's "Flangnek-Standard" meter run and orifice fitting for precision flow metering.—Daniel Orifice Fitting Co., Inc., 3352 Union Pacific Ave., Los Angeles, Calif.

Circle 425 on inquiry card.

WEIGHT

Electronic Weighing. New 8-page illustrated Bulletin 4106 covers design, installation, and operational factors associated with electronic weighing of tanks, bins, etc.—Baldwin-Lima-Hamilton Corp., Phila. 42, Pa.

Circle 426 on inquiry card.

Electronic Weighing. New 8-page Bulletin 4105 illustrates typical applications of maker's crane scales and indicating or recording instruments for weighing loads electronically.—Baldwin-Lima-Hamilton Corp., Phila. 42, Pa.

Circle 427 on inquiry card.

Portable Scales. New 6-page illustrated Bulletin W-1 presents features and specifications of maker's portable weight indicator.—W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

Circle 428 on inquiry card.

Universal Balances. New 6-page Bulletin 27 illustrates and describes features and operation of maker's universal projection balance.—Voland & Sons, Inc., New Rochelle, N. Y.

Circle 429 on inquiry card.

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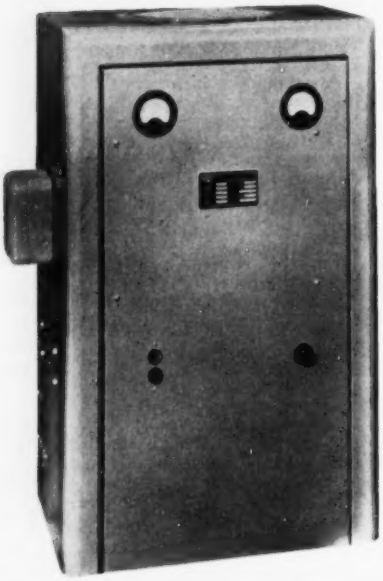

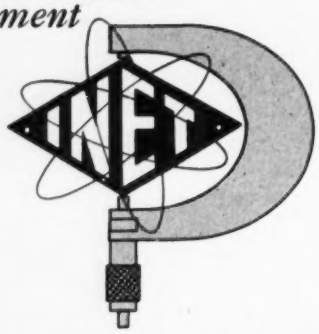

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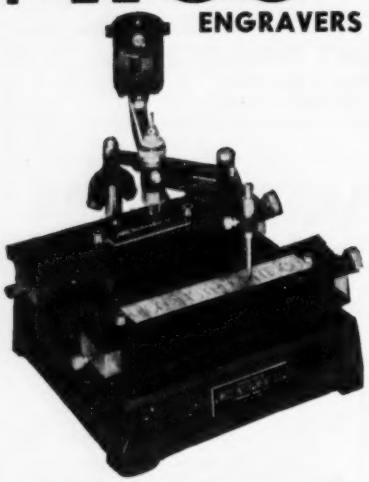

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NEW LITERATURE

Scales. New 4-page Form 3201 describes and illustrates maker's "Shadograph" scales for precision weighing. New 4-page Bulletin 3277 describes and illustrates six new models of 75-lb. capacity.—The Exact Weight Scale Co., Columbus 8, Ohio.

Circle 430 on inquiry card.

FORCE, TORQUE

Force, Displacement Transducer. New 2-page Bulletin 1-1 describes and illustrates maker's "Model G1" Force transducer. New 2-page Bulletin 15 covers maker's strain gage "Model SG-1." New 4-page "Instrument Notes" (No. 25) features article on pressure-sensing calculations for aircraft and guided missiles.—Statham Laboratories, Inc., 12401 W. Olympic Blvd., Los Angeles, Calif.

Circle 431 on inquiry card.

Torque-limiting Clutch. New Data Sheet S31-53 describes maker's line of torque-limiting slip-type friction clutches, including dimensions, capacities, and specifications.—Morse Chain Co., 7601 Central Ave., Detroit, Mich.

Circle 432 on inquiry card.

TESTING, INSPECTION

Instrument Test, Calibration. New 4-page bulletin describes and illustrates maker's rotary accelerator that provides a controlled variable centrifugal acceleration for calibrating or testing instruments, mechanisms, etc. New 4-page illustrated bulletin describes maker's temperature test chamber "Model TC-1."—Statham Development Corp., 12411 W. Olympic Blvd., Los Angeles, Calif.

Circle 433 on inquiry card.

Test Chambers. New 4-page Bulletin L1150-2 illustrates and describes maker's temperature, altitude, and relative-humidity test chambers.—Bowser Technical Refrigeration, Terryville, Conn.

Circle 434 on inquiry card.

Universal Testing Machine. New 4-page illustrated Bulletin LR-2 presents features of maker's multi-low-range Universal Tester for use on paper, thread, fabrics, plastics, glass, etc.—W. C. Dillon & Co., Inc., 14620 Keswick St., Van Nuys, Calif.

Circle 435 on inquiry card.

Orifice Edge Gage. New broadside presents description and use of maker's "Bean Orifice Edge Gage" for inspection of edges of metering orifices.—Lovins Engineering Co., 8203 Cedar St., Silver Spring, Md.

Circle 436 on inquiry card.

Surface Measurement. New 2-page Form LT81-4-53-10 describes and illustrates maker's "Type KC" tracer for surface-roughness measurements on internal tapers, shoulders, and hard-to-reach surfaces.—Micrometri-

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" -136	136°F
" -147	*147°F
" -174	174°F
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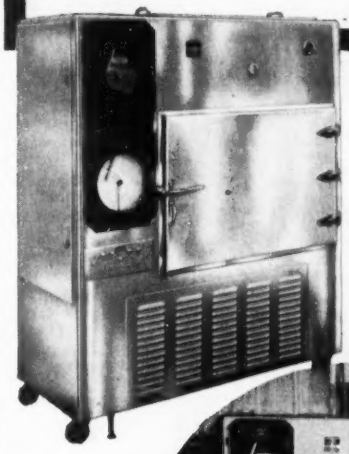

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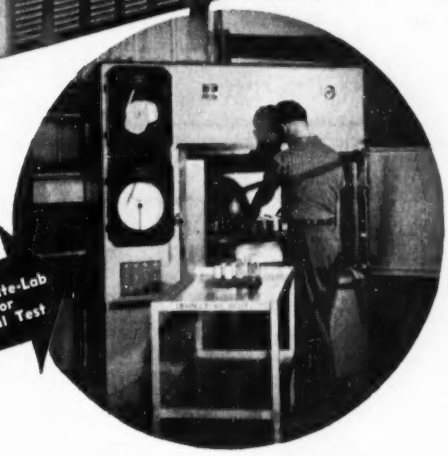

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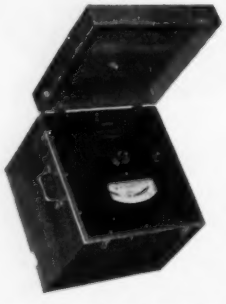

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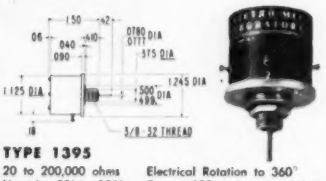

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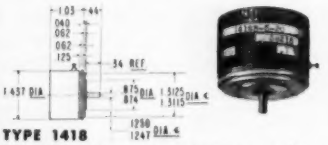

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For more information circle **165** on inquiry card.

NEW LITERATURE

cal Mfg. Co., 345 S. Main St., Ann Arbor, Mich.
Circle **437** on inquiry card.

Center-distance Gage. New 4-page illustrated Bulletin 652 presents features, operation, types and ranges of maker's "Center-Mike" for measuring distance between centers of holes.—Sorensen Center-Mikes, Inc., 264 Kossuth St., Bridgeport, Conn.
Circle **438** on inquiry card.

Vernier Caliper. New 4-page bulletin describes and illustrates maker's stainless-steel "Mauser 101" vernier caliper.—Geo. Scherr, 200 Lafayette St., New York, N. Y.
Circle **439** on inquiry card.

Groove Gage. New 2-page Form P-11G describes and illustrates maker's portable gage for checking internal grooves.—Bryant Chucking Grinder Co., Springfield, Vt.
Circle **440** on inquiry card.

Gage Blocks. New 24-page booklet 53-10 describes facilities, organization, and products of gage-block manufacturer. New 12-page brochure illustrates "What Users Say About DoAll Gages."—DoAll Company, 254 N. Laurel Ave., Des Plaines, Ill.
Circle **441** on inquiry card.

Soil Testing Apparatus. New 9-page Bulletin 20 describes facilities of maker's mobile soils laboratory for use in field testing of soils.—Soiltest, Inc., 4520 W. North Ave., Chicago, Ill.
Circle **442** on inquiry card.

Swivel Angle Plates. New 2-page Bulletin gives specifications and features of English-made heavy-duty swivel angle plates, rotary swivel angle tables, universal adjustable precision angle tables, and multi-angle jigs.—DeWitt Equipment Co., 136 Lafayette St., New York, N. Y.
Circle **443** on inquiry card.

HUMIDITY

Psychrometric Thermometers. New 4-page Catalog 12-A-20 describes and illustrates installation and application of pairs of fluid-filled temperature elements for indicating and/or recording relative humidity.—Fischer & Porter Co., Hatboro, Pa.
Circle **444** on inquiry card.

Moisture Control. New 4-page Bulletin describes features, operations, and application of German-made "Hygrotester." Also article on moisture control in machining and finishing paper, cardboard and cellulose.—Hygrotester Inc., Brooklyn 1, New York.
Circle **445** on inquiry card.

VISCOSITY

Viscosity. New 4-page bulletin describes and illustrates maker's "Ultra-Viscoson" for ultrasonic, instantaneous measurement and control of viscosity.—Bendix Aviation Corp., 203 West 3 St., Cincinnati, Ohio.
Circle **446** on inquiry card.

Viscosity. New illustrated Broadside presents features and models of "Brookfield Viscometers" for viscosity measurement and control.—Henry A. Gardner Laboratories, Inc., 4723 Elm St., Bethesda, Md.

Circle 447 on inquiry card.

ANALYTICAL

Analytical, Chemical, Physical Test Instruments. New 64-page Catalog GEC-1016A describes and illustrates over 115 testing and measuring devices for laboratory and production use, including electric-circuit testing, insulation testing, materials testing, chemical analysis, X-ray diffraction, color measurement, force, strain, vibration, temperature, radiation, etc.—General Electric, Schenectady 5, N. Y.

Circle 448 on inquiry card.

Automatic Titrator. New 2-page Application Data Sheet K-16-C describes application of maker's automatic titrator in rapid glycerine analyses.—Beckman Instruments Inc., South Pasadena 8, Calif.

Circle 449 on inquiry card.

Specific-gravity Meter. New 2-page bulletin describes and illustrates maker's specific-gravity meter that uses maker's radioactivity-type null-system for automatic measurement.—Ohmart Corp., Cincinnati 38, Ohio.

Circle 450 on inquiry card.

Chlorine Dispenser. New 12-page illustrated Catalog 61 describes new solution-feed dry vacuum "Ratochlor" chlorine dispenser. Includes specifications, flow diagram, and applications.—Fischer & Porter Co., Hatboro, Pa.

Circle 451 on inquiry card.

Spectrophotometry. New 8-page Bulletin BB-11-47 describes practical applications for maker's spectrophotometer in brewing industry, potash reclamation, oceanographic analyses, etc. Also article on 200-channel recorder.—Beckman Instruments, Inc., South Pasadena 1, Calif.

Circle 452 on inquiry card.

Nephelometery. New 6-page folder describes operation of maker's Nephelometer in measurement of haze or turbidity.—Coleman Instruments, Inc., 318 Madison St., Maywood, Ill.

Circle 453 on inquiry card.

Gas Testing Apparatus. New 16-page Bulletin AG-2 describes and illustrates maker's laboratory gas-testing apparatus—calorimeters, gravitometers, etc.—American Meter Co. Inc., 991 Broadway, Albany, N. Y.

Circle 454 on inquiry card.

LABORATORY APPARATUS

Medical & Biological Instruments, Apparatus. New 216-page illustrated Catalog 105 presents instruments, laboratory specialties, supplies and visual aids for medicine and biology including centrifuges, surgical instruments, catheters, anatomy models,

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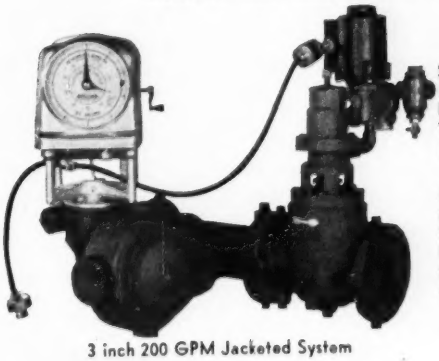

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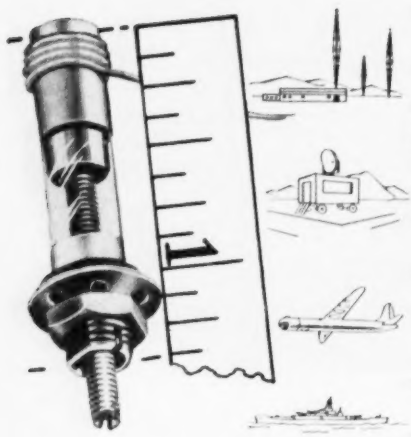

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NEW LITERATURE

projectors, etc.—Clay-Adams Co., Inc., 141 E. 25th St., New York 10, N. Y.
Circle 455 on inquiry card.

Laboratory Apparatus. New 20-page illustrated issue No. 53-6-51 of "Greene Bros. Announcer" presents distributor's line of laboratory apparatus, plus article on the National Bureau of Standards.—Greene Bros., Inc., 1812 Griffin St., Dallas 2, Texas.
Circle 456 on inquiry card.

Laboratory Apparatus. New 12-page illustrated brochure, "Lanco Review No. 4," presents maker's line of laboratory equipment and furniture.—Arthur S. LaPine and Company, 6001 S. Knox Ave., Chicago, Ill.
Circle 457 on inquiry card.

Laboratory Instruments, Apparatus, Supplies, Chemicals. New 1465-page encyclopedia-like Catalog 100 describes and illustrates many complete lines of laboratory instruments, apparatus, supplies, and reagent chemicals. Includes detailed index. Requests must be on company letterhead to—Advertising Dept., E. H. Sargent & Co., 4647 W. Foster Ave., Chicago, Ill.
Circle 458 on inquiry card.

Laboratory Chemicals, Apparatus. New 24-page illustrated issue, Vol 42, No. 2, of "Chemist Analyst" presents articles on pH of the system barium-chloride—barium-hydroxide, analysis of nickel sulfate, spot-test differentiation of monel metal and nickel silvers, etc.—J. T. Baker Chemical Co., Phillipsburg, N. J.
Circle 459 on inquiry card.

Chart of Elements. New 29 x 59 inch chart No. 12051 of elements includes atomic symbol, number, name of element, and atomic weight or mass number. No. 12053 includes electronic configuration, natural isotopes, oxidation states, valence electrons, melting and boiling points, and density. Small chart available for student use.—Central Scientific Co., 1700 Irving Park Rd., Chicago, Ill.
Circle 460 on inquiry card.

Laboratory Apparatus. New set of 10 illustrated brochures present features of distributor's laboratory instruments and apparatus, including scratch test apparatus for paints, moisture tester, tote carts, immersion heaters, electric ovens, viscometer, etc.—Henry A. Gardner Laboratories, Inc., 4723 Elm St., Bethesda, Md.
Circle 461 on inquiry card.

Lab. Oven. New 2-page data sheet presents maker's new "Duo-Vac" oven for drying under vacuum or standard atmospheric conditions.—Labline Inc., 217 N. Des Plaines St., Chicago, Ill.
Circle 462 on inquiry card.

Combustion Furnaces. New 4-page Bulletin LAB-735 R describes and illustrates maker's electric organic combustion furnaces. Includes specifications, preheating furnace.—Hevi Duty Electric Co., Milwaukee 1, Wis.
Circle 463 on inquiry card.

Vacuum Furnaces. New 4-page Catalog 770 discusses "Vacuum Furnaces

and Their Application to High-Vacuum Processing of Metals."—F. J. Stokes Machine Co., Vacuum Equipment Div., 5500 Tabor Rd., Phila., Pa.

Circle **464** on inquiry card.

OPTICAL

Fresnel Lenses. New 8-page brochure describes history, development and applications of "Frenelens" fresnels. Includes principles, features, and applications in comparators, projectors, and all optical systems.—Bolsey Corp. of America, 118 E. 25 St., New York, N. Y.

Circle **465** on inquiry card.

Color-difference Measurement. New 6-page Bulletin 131 describes and illustrates maker's instruments for measurement of color and color difference.—Gardner Laboratory, Inc., Bethesda 14, Md.

Circle **466** on inquiry card.

Brightness Meter. New 4-page bulletin describes and illustrates maker's "Spectra Brightness Spot Meter."—Photo Research Corp., 127 W. Alameda Ave., Burbank, Calif.

Circle **467** on inquiry card.

Copying Machine. New 4-page illustrated Bulletin F3-69 describes operation and uses for maker's "Verifax" copying machine for reproducing one to three duplicates of printed, typed, written, or drawn material within one minute.—Industrial Photographic Sales Div., Eastman Kodak Co., Rochester 4, N. Y.

Circle **468** on inquiry card.

Copying Equipment. New group of bulletins describe and illustrate various models of maker's "XeroX-Lith-Master" copying equipment for making offset paper masters, or single copies, from documents, forms, drawings, etc.—The Haloid Co., Haloid St., Rochester, N. Y.

Circle **469** on inquiry card.

SPEED, TIMING

Cycle, Interval, and Delay Timers. New 6-page illustrated data sheets present description, application, operation, and specifications of maker's interval, cycle, program, and delay timers.—G. C. Wilson & Co., Chatham, N. J.

Circle **470** on inquiry card.

Speed Control of Motors. New 4-page issue of "Bodine Motorgram" (Vol 33, No. 4) features article on speed-control characteristics of fractional-hp. motors.—Bodine Electric Co., 2250 W. Ohio St., Chicago, Ill.

Circle **471** on inquiry card.

RADIOACTIVITY

Radiation Detector. New 4-page booklet describes and illustrates maker's new miniature "Gamatek" radiation monitor and detector.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena, Calif.

Circle **472** on inquiry card.

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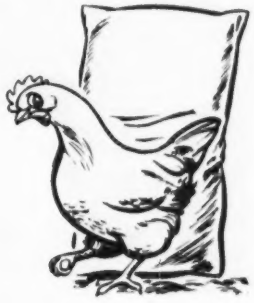

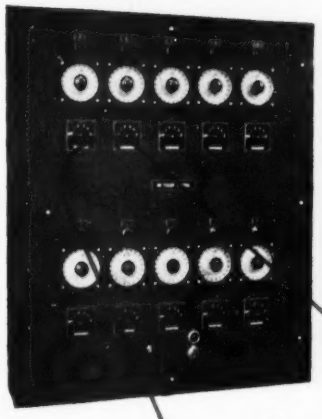

An Eagle control panel automatically proportions ingredients from ten bins onto a conveyor belt headed for a mixing chamber. Highest standards of control and faster production increase profit for the United Coop. Farmers Inc. at Fitchburg, Mass.

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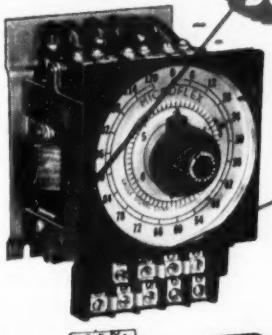

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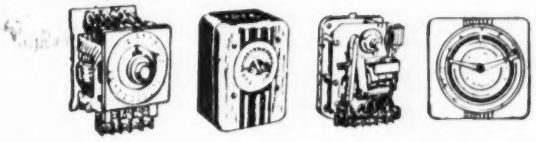

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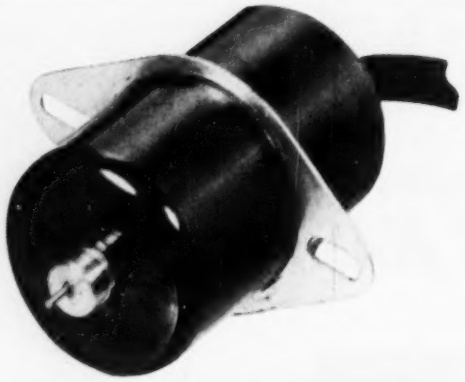

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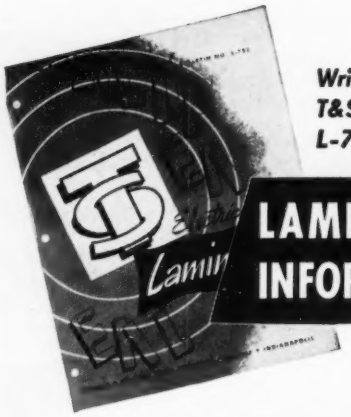

Write for NEW T&S Bulletin L-752

LAMINATION INFORMATION

Complete data on T&S laminations—including new "OrthoSil" oriented steel—with specification tables and graphs, magnetic characteristics and test results. Actual size drawings of special and standard shapes.

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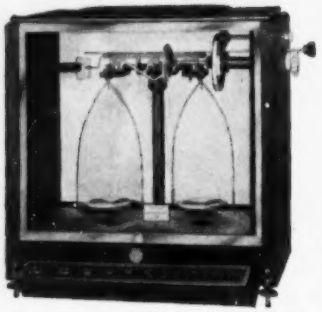

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NEW LITERATURE

Radioactivity Thickness Measurement. New 4-page bulletin describes and illustrates maker's new "Penetron Junior Model II" for wall-thickness measurement by gamma rays.—United Engineers, Inc., 824 E. 6 St., Tulsa, Okla.

Circle **473** on inquiry card.

Radiation Detector. New 6-page folder describes and illustrates maker's high-sensitivity gamma-radiation detector.—Welch Allyn, Inc., Skaneateles Falls, N. Y.

Circle **474** on inquiry card.

RECORDING

Multi-channel Oscillograph. New 8-page Bulletin GEC-396A describes and illustrates maker's "Type PM-13" seven-element automatic oscillograph.—General Electric, Schenectady 5, N. Y.

Circle **475** on inquiry card.

Magnetic Recorder. New 2-page bulletin describes and illustrates maker's new "Type 103" magnetic transient recorder for DC to 30,000 cycles.—Magne-Pulse Corp., 140 Nassau St., New York, N. Y.

Circle **476** on inquiry card.

COMPUTING

Digital Data Processing. New 64-page issue (Vol. 56, No. 4) of "General Electric Review" has articles on digital data processing, metal strength, balancing turbine rotors, etc.—General Electric Co., Schenectady, N. Y.

Circle **477** on inquiry card.

Ball and Disk Integrator. New Catalog Sheet 304061 presents features, application, and specifications for maker's ball and disk integrator, a computer element for totalizing rate determination and differential analyzing.—Librascope, Inc., 1607 Flower St., Glendale, Calif.

Circle **478** on inquiry card.

RADIO, TV

Industrial TV. New 4-page Bulletin 1025-A describes and illustrates maker's "Model 300-B Utiliscope" industrial TV unit. 8-page reprint describes "TV in Industry."—Diamond Power Specialty Corp., Lancaster, Ohio.

Circle **479** on inquiry card.

Carrier Communications. New 4-page bulletin describes and illustrates maker's "Telecrane" FM carrier communications system which uses existing electrical circuits for intercommunication.—Mine Safety Appliances Co., Braddock, Thomas and Meade Sts., Pittsburgh, Pa.

Circle **480** on inquiry card.

Carrier-system Filters. New 8-page issue Vol 2, No. 6 of "Demodulator" describes factors involved in designing carrier-system filters; explains principle of new 24-channel cable carrier

system.—Lenkurt Electric Co., San Carlos, Calif.

Circle 481 on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

Electrical, Acoustic, Physical Measurements. New 34-page illustrated book describes 37 instruments for electrical, physical, ultrasonic energy and electro-acoustical measurements. Includes principles, features, and applications. Request on company letterhead to—Sales Promotion Dept., Brush Electronics Co., 3405 Perkins Ave., Cleveland, Ohio.

Circle 482 on inquiry card.

Noise Measurement. New 8-page illustrated issue, Vol. 28 No. 1, of "Experimenter" presents method of approximate frequency analysis from weighting-network data in acoustic noise measurements.—General Radio Co., 275 Massachusetts Ave., Cambridge, Mass.

Circle 483 on inquiry card.

Handbook of Noise Measurement. New 124-page "Handbook of Noise Measurement" covers principles, definitions, standards, measuring equipment, procedures, and interpretations of results for all types of airborne sound. Includes references, db tables, and catalog section for instruments. Price $1.00.—General Radio Co., Cambridge, 39, Mass.

Circle 484 on inquiry card.

DC Power Amplifier. New 4-page bulletin describes and illustrates maker's "Model B" DC power amplifier for applications in sonic and subsonic frequency ranges.—Southwestern Industrial Electronics Co., Inc., 2831 Post Oak Rd., P. O. Box 13058, Houston, Texas.

Circle 485 on inquiry card.

Inverter-Amplifier. New 2-page bulletin describes and illustrates maker's "Model 205" inverter-amplifier, a high-gain DC pre-amplifier for cathode-ray oscillographs and tape recorders.—Allegany Instrument Co., 1000 Oldtown Rd., Cumberland, Md.

Circle 486 on inquiry card.

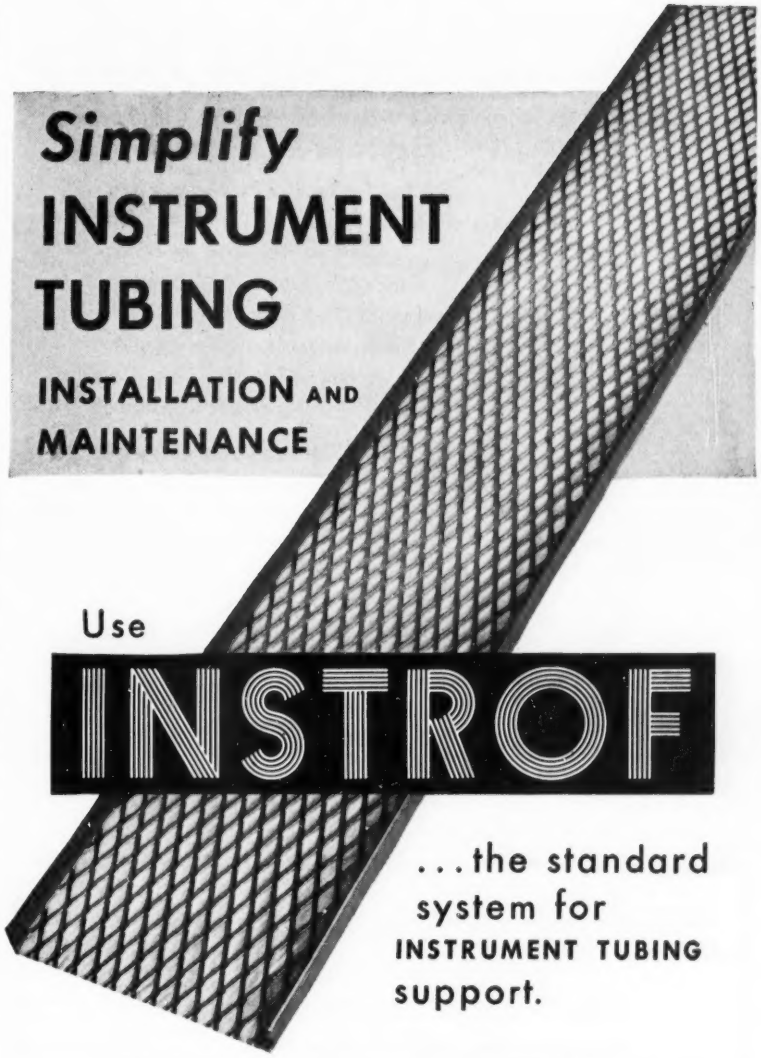
Decade Box. New 2-page bulletin describes and illustrates maker's "Dekabox", precision resistor decade box featuring maker's "Dekadial."—Brown Electro-Measurement Corp., 4635 S.E. Hawthorne Blvd., Portland, Ore.

Circle 487 on inquiry card.

Resistance Testers. New 8-page Bulletin 21-85 describes and illustrates maker's "Megger" testers, including midget insulation tester, "CVM Type" insulation tester, and midget circuit-testing ohmmeter.—James G. Biddle Co., 1316 Arch St., Phila., Pa.

Circle 488 on inquiry card.

Magnetic Pick-up Impulse Generator. New 2-page Bulletin MP-592 presents features and applications of maker's magnetic pick-up impulse generator for indicating rate of motion at all speeds.—Electro Products



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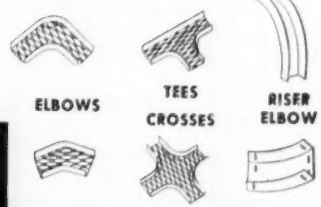

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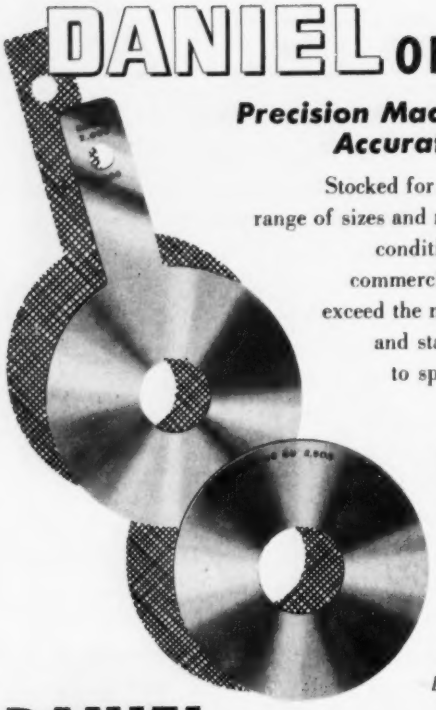

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NEW LITERATURE

Laboratories, Inc., 4501 Ravenswood Ave., Chicago, Ill.
Circle 489 on inquiry card.

Spectrum Generator. New 2-page Bulletin TDS 1232B describes and illustrates maker's spectrum generator secondary frequency standard "Model 1232B." 2-page Bulletin TDS 1322 covers maker's "Model 1322 Servotherm" low-frequency pre-amplifier. —Servo Corp. of America, 20-20 Jericho Turnpike, New Hyde Park, N. Y.
Circle 490 on inquiry card.

Pulse Generators. New 4-page bulletin describes and illustrates maker's new square-pulse generators for millimicrosecond to microsecond range—Electrical and Physical Instrument Corp., 25 West 43 St., New York, N. Y.
Circle 491 on inquiry card.

Multi-meter. New 2-page bulletin describes and illustrates maker's "Model 269" 100,000-ohms-per-volt volt-ohm-microammeter.—Simpson Electric Co., 5200 W. Kinzie St., Chicago, Ill.
Circle 492 on inquiry card.

Current Controller. New 12-page illustrated Bulletin 505.00 gives operating characteristics and applications of maker's "Regohm," a solenoid-actuated finger-type controller for armatures, dynamotors, voltage, current, servos, etc.—Electric Regulator Corp., Pearl St., Norwalk, Conn.
Circle 493 on inquiry card.

Signal Generator. New 2-page bulletin describes and illustrates maker's "Model 100C" FM signal generator for 25-216 Mc.—New London Instrument Co., New London, Conn.
Circle 494 on inquiry card.

Capacitor Indicator. New 2-page bulletin describes and illustrates maker's portable capacitor indicator for test and inspection.—Lindell Electric Control Corp., 57 Lispenard St., New York, N. Y.
Circle 495 on inquiry card.

Phase-sequence Indicators. New 2-page bulletin presents maker's phase-sequence indicators that combine function of pilot light and phase-sequence indicator for portable three-phase equipment.—Brunswick Instruments, 29 Cleremont Ave., New Brunswick, N. J.
Circle 496 on inquiry card.

Electronic Test Instruments. New 4-page illustrated brochure presents maker's line of electronic test instruments—"Q" indicator, megohmmeter, bridges, power supplies, null detectors, VTVM, decade inductor, decade capacitor, harmonic distortion meter, etc.—Freed Transformer Co., Inc., 1718 Weirfield St., Brooklyn, N. Y.
Circle 497 on inquiry card.

POWER SUPPLIES

Transistor Supply. New 2-page bulletin describes and illustrates maker's tubeless regulated dual DC supply unit "Model 110" for transistor appli-

cations.—Electronic Research Associates, Dept. B1, Box 29, Caldwell, N. J.
Circle 498 on inquiry card.

Constant-current Converter. New Broadside describes and illustrates maker's instrument for converting any power supply into a constant-current generator for transistor circuits, etc.—Electronic Research Associates, Dept. B2, Box 29, Caldwell, N. J.
Circle 499 on inquiry card.

Power Supplies. New 6-page illustrated Bulletin L453 lists types and features of maker's DC power supplies. Insert sheet lists literature available from maker and specification questionnaire.—Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif.
Circle 500 on inquiry card.

RELAYS, SWITCHES

Thermostats, Relays. New 2-page issue No. 3 of "Instrument News" presents uses of maker's relays and thermostats in operation on railroads, utility systems, etc.—Instrument Div., Thomas A. Edison, Inc., West Orange, N. J.
Circle 501 on inquiry card.

Resistance-sensitive Relay. New 4-page Bulletin GEA-5893 describes and illustrates maker's electronic resistance-sensitive relay for control of motors, liquid level, sorting, solenoids, etc.—General Electric Co., Schenectady, 5, N. Y.
Circle 502 on inquiry card.

Relays. New 4-page bulletin describes and illustrates maker's "ultra sensitive" relays for industrial and laboratory use, which operate on currents of 0.1, 0.01, and 0.001 microampere.—Devtronics, Inc., 221 N. Hermitage Ave., Trenton, N. J.
Circle 503 on inquiry card.

Switches. New 16-page Bulletin RC-9B, describes and illustrates maker's many models of line and slide switches. Includes ratings and specifications.—Stackpole Carbon Co., St. Marys, Pa.
Circle 504 on inquiry card.

Toggle Switches. New 8-page illustrated Catalog 73 presents characteristics, construction features, and electrical ratings of maker's large line of toggle switches.—Micro Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.
Circle 505 on inquiry card.

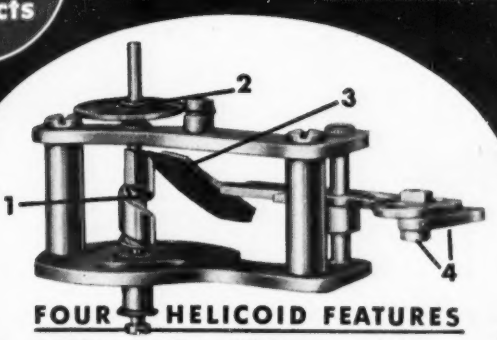
Push-button Switches. New 8-page Bulletin GEA-5779 describes and illustrates maker's line of oil-tight pushbuttons.—General Electric, Schenectady 5, N. Y.
Circle 506 on inquiry card.

Limit Switch. New 2-page Data Sheet 73 describes and illustrates maker's "Type ML" explosion-proof limit switch.—Micro Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.
Circle 507 on inquiry card.

Precision Switches. New 4-page Vol. 1 No.-10 illustrated edition of "Micro Tips" presents new uses for maker's

ACCO products

HELICOID GAGES



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NEW LITERATURE

"Micro" switches in safety devices for machinery, automatic weighing, remote control, etc.—Micro Div., Minneapolis Honeywell Regulator Co., Freeport, Ill.

Circle 508 on inquiry card.

Circuit Breakers. New 12-page Bulletin 1/52 ETA 1.4.52, describes and illustrates German-made single-pole thermally-operated miniature overcurrent circuit breakers.—ETA Products Co., 915 W. Oakdale Ave., Chicago, Ill.

Circle 509 on inquiry card.

Power Circuit Breaker. New 4-page Bulletin 71B7942 describes and illustrates maker's "Pneu-Draulic" operator for AC power circuit breakers—a pneumatic operator incorporating hydraulics to transmit power.—Allis-Chalmers Mfg. Co., 942 S. 70 St., Milwaukee, Wis.

Circle 510 on inquiry card.

TRANSISTORS, TUBES, RECTIFIERS

Transistors. New 28-page illustrated brochure "Sylvania and Transistors" covers principles, construction, types, and applications of transistors, plus manufacturer's program for future.—Sylvania Electric, Electronics Div., Woburn, Mass.

Circle 511 on inquiry card.

Power Triode. New 2-page data sheet presents dimensions, rating, and diagram of maker's high-mu power triode "Type 100TH."—Lewis and Kaufman, Inc., Los Gatos, Calif.

Circle 512 on inquiry card.

Rectifiers, Diodes, Photoelectric Cells. New 4-page illustrated Bulletin JRP-1 presents maker's line of selenium rectifiers, photoelectric cells, and selenium and germanium diodes.—International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.

Circle 513 on inquiry card.

High-Vacuum Rectifier. New 2-page data sheet describes and illustrates maker's "Type 705A" thoriated-tungsten high-vacuum rectifier.—Lewis and Kaufman, Ltd., 134 El Rancho Ave., Los Gatos, Calif.

Circle 514 on inquiry card.

Selenium Rectifiers. New 8-page Technical Data Sheet 52-650 describes and illustrates maker's "Type K Magamp" selenium rectifier for magnetic-amplifier circuits and sensing devices.—Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.

Circle 515 on inquiry card.

CONNECTORS

Solderless Wire Connectors. New 16-page illustrated Catalog 53 presents specifications, dimensional data, and applications for maker's line of solderless wire connectors and specialized electrical fittings.—Buchanan Electrical Products Corp., Hillside, N. J.

Circle 516 on inquiry card.

Connectors. New 24-page illustrated Catalog describes distributor's line of electronic precision "Continental" multi-contact connectors.—DeJur Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.

Circle **517** on inquiry card.

Connectors. New 4-page issue of "Amphenol Engineering News" (Vol. 6, No. 3) covers new connectors and applications.—American Phenolic Corp., 1830 S. 54 Ave., Chicago, Ill.

Circle **518** on inquiry card.

ELECTRONIC COMPONENTS

Electronic Components. New 24-page Catalog 973 describes and illustrates maker's capacitors, insulators and bushings, tube sockets, inductors, knobs, dials, etc.—E. F. Johnson Co., Waseca, Minn.

Circle **519** on inquiry card.

Printed Circuits. New 4-page bulletin describes and illustrates maker's printed circuits. Includes materials, applications, and manufacturing facilities.—Centronics Co., 21-04 122 St., College Point, N. Y.

Circle **520** on inquiry card.

Nonlinear Resistors. New 6-page Catalog Bulletin SR-3 presents voltage characteristics, current ratings, temperature characteristics, typical applications, and dimensions of maker's "Varistors," nonlinear resistors.—International Resistance Co., 401 N. Broad St., Phila., Pa.

Circle **521** on inquiry card.

Microtorque Potentiometer. New 4-page bulletin describes and illustrates maker's "Telepot" microtorque potentiometer. Includes models and features.—F. H. Paul & Stein Bros., Inc., 100 Gold St., New York, N. Y.

Circle **522** on inquiry card.

Ferromagnetic Cores. New 8-page Bulletin RC-9A describes and illustrates maker's "Ceramag" ferromagnetic cores.—Stackpole Carbon Co., St. Marys, Pa.

Circle **523** on inquiry card.

Delay Lines. New Broadside gives features, special design, and technical data of maker's flexible distributed-constant delay lines for delays from 0.1 to 3 microseconds.—Richard D. Brew & Co., Inc., 106 Concord Ave., Belmont, Mass.

Circle **524** on inquiry card.

Cable Clips. New 2-page Bulletins E-1, N-1, and D-1 describe and illustrate maker's cable clips "Etholoc" made of ethyl cellulose; "NyLoc" of nylon; and "D" washers for use with plastic cable clips, respectively.—Weckesser Co., 5261 N. Avondale Ave., Chicago, Ill.

Circle **525** on inquiry card.

Capacitors. New 2-page Bulletin 199 describes and illustrates maker's piston-type variable trimmer capacitors. Includes ranges, construction, and features.—JFD Mfg. Co., Inc., 6101 16th Ave., Brooklyn, N. Y.

Circle **526** on inquiry card.

Transformers. New 4-page Bulletin E100 lists types, features, and dimen-

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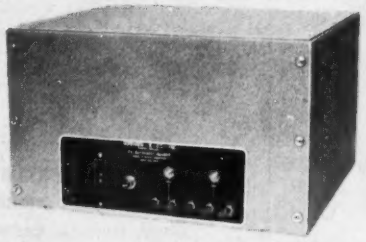

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The Stability of the E-6/2-5 Nobatron is accomplished electronically, with no moving parts and a minimum of tubes. Two years' rigorous testing of prototype instruments have yielded results far exceeding specifications. Write for information today.

SPECIFICATIONS

Input voltage range	95-130VAC, 1o, 50-60 cycles
Output	
#1 for lamp	6VDC adjustable ±10% at 5 amperes
#2 for filament	6VDC at 100 Ma.
#3 for bias	2VDC adjustable ±10% at 100 Ma.
Filtering	
#1	.1% max.
#2 & 3	0.05% max.
Regulation accuracy	±0.01% against line changes
Time constant	0.1 seconds under most severe line changes
Size:	17 x 12¼ x 17 self contained 19 x 12¼ panel for relay rack mounting
Weight:	Approximately 90 pounds
Meters:	No meters are provided due to the extreme regulation accuracy involved.

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The Tennessee Valley Authority wants experienced instrument mechanics for work in chemical plants at Wilson Dam, Alabama. The work is inspecting, testing, repairing, adjusting, and calibrating service instruments, including actuating connections and control equipment. Instruments are electrical, mechanical, pneumatic, hydraulic, thermal, or any combination of these. Salary is $4500 per year for 40-hour week. Liberal vacation leave, sick leave, and retirement benefits.

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For more information circle 186 on inquiry card.

Leading nuclear instrument manufacturer desires sales manager. Must have sales experience in instrumentation. State age, experience, salary desired, and enclose photo with first communication. Box 243, Instruments Publishing Company, 845 Ridge Avenue, Pittsburgh 12, Penna.

For more information circle 187 on inquiry card.

DISTRIBUTOR WANTED:

To merchandise a complete line of Industrial Thermometers, Mercury Thermostats & Hydrometers. This manufacturer is recognized as A-1 in the industry and wishes to expand their distribution. Will welcome inquiries from responsible principals. Box 242, Instruments Publishing Co., 845 Ridge Ave., Pittsburgh 12, Penna.

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Progressive Manufacturer Automatic Controls has opening for Manager Industrial Division with broad instrument and process control sales background. Midwest location. Salary and Bonus. Permanent Career—Opportunity unlimited. Box 230, Instruments Publishing Company, 845 Ridge Avenue, Pittsburgh 12, Pa.

For more information circle 189 on inquiry card.

NEW LITERATURE

sions of maker's large line of transformers, filters, and reactors.—Electro Engineering Works, 6021 College Ave., Oakland, Calif.

Circle 527 on inquiry card.

Miniature Pulse Transformers. New 2-page Bulletin DL-K-320 describes maker's miniature pulse transformers for blocking-oscillator usage.—Raytheon Mfg. Co., Waltham, Mass.

Circle 528 on inquiry card.

Variable Inductor. New 2-page Bulletin 1/653 describes and illustrates maker's new "Model PA-63" variable inductor.—Vari-L Co., Inc., Box 1433, Stamford, Conn.

Circle 529 on inquiry card.

Clamps, Brackets. New 64-page 1953 Engineering Manual covers maker's complete line of 40,000 types and sizes of bare metal and cushioned line support clamps, wire harness and multiple support clamps, brackets, busbars, etc.—Thomas Associates, 4607 Alger St., Los Angeles, Calif.

Circle 530 on inquiry card.

Hermetic Sealed Terminals. New 4-page bulletin presents maker's line of hermetically sealed terminals and headers for use in electronic equipment.—Glass Solder Engineers, 845 El Centro St., South Pasadena, Calif.

Circle 531 on inquiry card.

Test-point Jacks. New 2-page Bulletin TJ-1 describes and illustrates maker's phone-tip jack to accomodate standard RTMA 0.081-dia. phone tip.—Cannon Electric Co., 3209 Humboldt St., Los Angeles, Calif.

Circle 532 on inquiry card.

Knobs, Handles. New 12-page illustrated catalog presents maker's line of molded plastic control knobs and handles, dials, sockets, and other plastic parts.—Rogan Bros., 2001 S. Michigan Ave., Chicago, Ill.

Circle 533 on inquiry card.

Teflon Insulators. Four new 2-page bulletins describe and illustrate maker's "press-fit" miniature Teflon insulators, sub-miniature Teflon standoff insulators, and "feed-thru" insulators. Includes installation procedure.—Sealectro Corp., 186 Union Ave., New Rochelle, N. Y.

Circle 534 on inquiry card.

VALVES

Solenoid Valves. New 80-page illustrated Catalog 24 presents maker's line of solenoid valves, including flow charts and specifications for hundreds of models, plus midget valves, time-delay valves, explosion-proof solenoids, etc. Special Bulletin 8336 presents applications, operation, features, and general description of solenoid pilot-controlled valve.—Automatic Switch Co., 391 Lakeside Ave., Orange, N. J.

Circle 535 on inquiry card.

Solenoid Valves. New 4-page Bulletin lists features and types of maker's

solenoid valves. Insert sheet gives applications and dimensioned diagrams.—Jackes-Evans Mfg. Co., 4427 Geraldine Ave., St. Louis, Mo.

Circle 536 on inquiry card.

PUMPS

Gear Pumps. New 24-page Bulletin 17-A describes and illustrates maker's "SK" gear pumps engineered to meet unusual requirements. Includes dimension drawings, tables of capacities, pressures, and operational data.—Dept. P-E, Schutte & Koerting Co., Cornwells Heights, Bucks County, Pa.

Circle 537 on inquiry card.

Pump Control. New 8-page illustrated Bulletin S-53 describes maker's recirculation control systems for protecting high-capacity centrifugal boiler pumps during low-load conditions.—Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.

Circle 538 on inquiry card.

High-vacuum Pumps. New 36-page illustrated Catalog 750 presents formulae, constants, and conversions used in vacuum processing, plus maker's line of pumps for high vacuum. Also presented are typical problems, solutions, and vacuum gages.—F. J. Stokes Machine Co., 5500 Tabor Rd., Phila., Pa.

Circle 539 on inquiry card.

AIR

Pipe-line Filters. New 4-page illustrated Bulletin 210 describes features of maker's "Staynew" pipe-line filters for low pressures up to 40 psi. Includes models and ranges.—Dollinger Corp., 11 Centre Pk., Rochester, N. Y.

Circle 540 on inquiry card.

Air Aftercoolers. New 4-page bulletin describes and illustrates maker's water-cooled aftercoolers for dehydrating compressed-air systems from 100 to 500 cfm.—Heat-X-Changer Co., Inc., Brewster, N. Y.

Circle 541 on inquiry card.

Filters, Strainers. New 110-page catalog describes and illustrates maker's large lines of "Auto-clean, Flo-clean, and Micro-clean" filters for industrial uses.—Cuno Engineering Corp., Meriden, Conn.

Circle 542 on inquiry card.

Compressed-air Meter. New 4-page illustrated bulletin A-7 presents features of maker's "Drill-Om-Eter" and "Tool-Om-Eter" for measuring air consumption of pneumatic tools, drills, motors, etc.—New Jersey Meter Co., Plainfield, N. J.

Circle 543 on inquiry card.

TUBING, FITTINGS

Flexible Metal Hose. New 52-page illustrated Catalog 200 presents maker's large line of corrugated metal hose plus description of its manufacturing methods, applications, and spec-

Scientifically controlled tests, impartially conducted, to determine the comparative accuracy of several flowmeters of popular designs have conclusively proved the superior advantages of Barton's Dual-Bellows meter body. The Barton was the only flowmeter that averaged less than 1% deviation from perfect calibration over a 100°F change in meter temperature; others tested deviated as much as 3%. The ingeniously engineered Barton Meter Body insures a higher order of accuracy when the instrument is subjected to normal day and night air temperature variations.

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NEW LITERATURE

ifications. Includes "Titeflex" helically-wound and "Uniflex" helically-corrugated metal tubing.—Titeflex, Inc., 500 Frelinghuysen Ave., Newark, N. J.

Circle **544** on inquiry card.

Flexible Metal Hose. New 4-page Bulletin 15-D illustrates and describes types and features of maker's flexible metal hose.—Atlantic Metal Hose Co., Inc., 123 W. 64 St., New York, N. Y.

Circle **545** on inquiry card.

Tubing Fittings. New 2-page Catalog File 4310 A 11 illustrates and lists maker's line of "Triple-lok CCC BTX" extra-long male elbows.—Parker Appliance Co., 17325 Euclid Ave., Cleveland, Ohio.

Circle **546** on inquiry card.

SHOP EQUIPMENT

Precision Tools. New 4-page "Bargain List 53" presents hundreds of imported quality precision tools—files, hole gages, nippers, pliers, watchmaker's tools, etc.—Modern Technical Supply Co., 55 W. 42 St., New York, N. Y.

Circle **547** on inquiry card.

Scientific Dictionary. New 2-page illustrated Bulletin 139 briefly describes features of new 4th edition of "Stewart's Scientific Dictionary," a 1000-page dictionary of terms for chemical processing, plastic, paint, and other industries.—Gardner Laboratory, Inc., Bethesda 14, Md.

Circle **548** on inquiry card.

Potting Compound. New 4-page bulletin describes maker's "P 420" potting compound. New 4-page bulletin covers bonding agent "R-313" for bonding of dissimilar materials, "Flawmaster" surface compound, electrical varnish, and potting compound. —Carl H. Biggs, Co., Inc., 2255 Barry Ave., Los Angeles, Calif.

Circle **549** on inquiry card.

Instrument Service. New 4-page Bulletin DM034 describes maker's nation-wide service organization available to instrument users.—Bristol Co., Waterbury 20, Conn.

Circle **550** on inquiry card.

Fly Cutter. New 4-page bulletin describes and illustrates maker's "Model 800" fly cutter and "Model 801" round-shank fly cutter.—Mico Instrument Co., 86 North Trowbridge St., Cambridge, Mass.

Circle **551** on inquiry card.

Wire Cloth. New 4-page illustrated Bulletin 106 presents uses and types of wire cloth for industrial application.—Cambridge Wire Cloth Co., Cambridge, Md.

Circle **552** on inquiry card.

Planimeters. New 4-page Bulletin 171M describes (in 3 languages) and illustrates German-made planimeters, tracing magnifiers, integrators, harmonic analyzers, and pantographs.—Geo-Optic Co., Inc., 170 Broadway, New York, N. Y.

Circle **553** on inquiry card.

INSTRUMENT EVENTS Calendar

August 10-September 5

Meeting of Commission for Instruments and Methods of Observation of World Meteorological Organization, Toronto, Canada. For information contact Dr. G. Swoboda, Campagne Rigot, Avenue de la Paix, Geneva, Switzerland.

August 24-26

Appalachian Gas Measurement Short Course, West Virginia University, Morgantown, W. Va. For information write G. W. Stuart, Equitable Gas Company, 3325 Hyperion St., Pittsburgh 14, Penna.

September 8-12

Fourth International Colloquium for Spectroscopy, Society for the Advancement of Spectrochemistry and Applied Spectroscopy, Muenster, Germany.

September 9-11

Conference on Nuclear Engineering, University of California. For information write R. A. Fayram, University of California, Berkeley, Calif.

September 9-11

Association for Computing Machinery meeting at Mass. Institute of Technology, Cambridge, Mass.

September 9-15

Royal Meteorological Society Meeting in conjunction with 124th National Meeting of American Meteorological Society, Toronto, Canada. Contact Kenneth C. Spengler, 3 Joy St., Boston 8, Mass.

September 21-25

Eighth National Instrument Conference & Exhibit, Sherman Hotel, Chicago, Ill. For information write P. V. Jones, Mgr., Instrument Society of America, 1319 Allegheny Ave., Pittsburgh 33, Pa.

September 22-25

Third Biannual meeting of the Chambre Syndicale Nationale de la Mechanique de Haute Precision. Theme: "Contribution of the Metrology and High-precision Mechanics to the Suppression of Rejects." Paris, France. For information write G. Dumez, President, 37 Avenue de Breteuil, Paris VII, France.

September 28-30

Ninth National Electronics Conference and Exhibition, Sherman Hotel, Chicago. For information write Karl Kramer, Executive Secretary, 852 E. 83 St., Chicago 19, Ill.

Oct. 14-16

Midyear Meeting of Recorder-Controller Section, SAMA, Seaview Country Club, Absecon, N. J.

October 30-31

Annual meeting of Pacific Coast Section, Society of Exploration Geophysicists, Statler Hotel, Los Angeles, Calif. For information write SEG, Box 7248, Tulsa 18, Oklahoma.

November 13-14

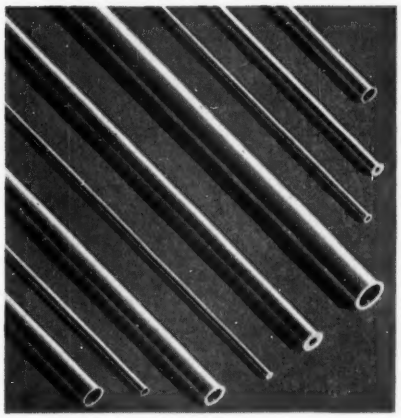
Annual I.R.E. Electronics Conference and Exhibition, Hotel President, Kansas City, Mo. For information write D. L. Welborn, 1400 Chestnut, Kansas City, Mo.

November 18-20

American Institute of Electrical Engineers Conference on Electronic Instrumentation and Nucleonics in Medicine, New York, N. Y. For information write Raymond C. Mayer Associates, 9 Rockefeller Plaza, New York.

November 19-20

Third Annual Instruments Short Course at Los Angeles Harbor Junior College. For information write Edward A. Reps, Southern Counties Gas Co., Box 2736 Terminal Annex, Los Angeles 54, Calif.



Yes, it's tubing—Uniform "Pointer" tubing used as the indicator in this Simpson Electric Company Model #1029 Milliammeter. Uniform pioneered the development of delicate, aluminum alloy "Pointer" tubing; today furnishes over 50% of all such tubing used in the United States.

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For more information circle 194 on inquiry card.

PRODUCT INDEX

For more information on the following advertised products, circle product number on postage-free card on page 1253.

PROCESS CONTROL

Process Monitor, Alarms, Panellit 15
Metagraphic Instrument System, Bristol 16
Bi-Act, Tri-Act Controllers, Taylor 19
12000 Series Controllers, Masoneilan 28
Telemaster Central Control, Republic 31
Combustion Control Systems, Hagan 33
Electronic Control System, M M&Moore 40
Process Control, Wheelco 53
Process Instrumentation, M-Honeywell 92
Process Instrumentation, Bristol 131
Autronic Control System, Swartwout 155

TEMPERATURE

Thermocouples, Bulbs, Wire, Lewis 6
Sylphon Temp. Regulators, R-Fulton 18
Pyrometer Conversion Kit, Pyrom. Serv. 20
Potentiometer, Bridge Pyrometer, Thermo-Electric 24
Pyrometer Supplies, Industrial Pyrom. .. 36
Portable Temp. Recorder, Gotham 39
Rayotube Pyrometers, Leeds & Northrup 46
Temperature Monitor, Alarm, Edison 47
Electronic Bridges, General Controls 49
Temperature Control, Wheelco 53
Mercury-actuated Thermometers, Palmer 54
Pt-Pt-Rhodium Thermocouples, Gordon 58
Thermostatic Bimetal, Chace 76
Vertical-scale Temp. Indicator, M-Honeywell 92
Thermowells, Karn Chemical 93
Thermowells, Trinity Equipment 99
Dial Thermometers, Rochester 114
Temp. Indicators, Recorders, Auto-Lite 116
Thermistors, Bendix-Friez 118
Pyrotron Thermometers, Bailey 119
Immersion Thermocouples, L & Northrup 120
Pyrometer Data Book, Bristol 131
Temp.-operated Switches, Burling 132
Thermometers, Marsh 133
Industrial, Lab Thermometers, Moeller 140
Pyrotac Control, Illinois Testing..... 146
Temperature Recorders, Foxboro 150
Pyrometer Supplies, Richards 193
Infrared Detector, Epply Laboratory 196

PRESSURE

Mass-spec. Leak Detector, Consol. Eng. 8
Precision Dial Manometers, W & Tiernan 14
Bellows Assemblies, Robertshaw-Fulton 18
Pressure, Temp. Gages, U S Gage 23
Pressure Control, Leslie 25
Differential-pressure Controller, Foxboro 27
Draft, Pressure Instruments, Republic.... 31
Ashcroft Gages, M M & Moore 40
Pressure, Motion Pots, Bourns 60
Pressure-actuated Switches, Barksdale.... 65
Barometers, Altimeters, Ideal Lab. 67
Dead-weight Gage Tester, Amthor 83
Piezoelectric Materials, Brush Electronics 84
Pressure Regulator, Foster Engineering 85
Pressure Switches, Giannini 91
Pressure, Accel. Transducers, Rahm 100
Pressure, Motion Transducers, Colvin 129
Pressurized Manometers, Meriam 130
Pressure Gages, Marsh 133
Gages, Thermometers, Marshalltown 142
Pressure, Accel. Pickup-Indicator, Rutishauser 138
Manometers, Trimount 153
Diff.-pressure Transmitter, Swartwout 155
Pressure Gages, Acragage Corp. 170
Pressure, Motion Pickup, Transistron 172
Helicoid Pressure Gages, Am. C & C 179
Precision Dial Gages, Heise Bourdon 180

FLOW

Telecounter Remote Base-volume Gas Indicator, American Meter 12
Controlled Volume Pulsafeeder, Lapp 22
Electric Flow Meter, Republic 31
Ring Balance Meters, Hagan 33
Flow Tubes, Foster Eng. 85
Massometer Solids Flowmeter, W & Tiernan 147
Fluidometer Batch Meter, H & Berner 167
Orifice Plates, Daniel Orifice 176
Bellows-type Flowmeters, Barton 190

WEIGHT, LOAD

SR-4 Load Cells, Baldwin-L-H 34
Balances, Analytical, Micro, Gamma-B 94
Pneumatic Weight Transmitters, Monsell 103
Load, Motion Pickup, Transistron 172
Analytical Balances, American Balance 174

LEVEL

12000 Series Level Control, Masoneilan 28
Electronic Level Gage, Control, Fielden 30
Liquid-level, Float Switches, Revere 43
Electronic Level Control, Trimount 153
Hydrostatic Tank Gage, Uehling 181

HUMIDITY

Recording Psychrometers, Gotham 39
Recording Psychrometers, Moeller 140

ANALYTICAL

Mass Spectrometer, Consolidated Eng. 8
Recording Spectrophotometer, Beckman 29
Continuous Gas Analyzer, Alarm, Davis 45
Gas Detector, Alarm, J-Williams 56
Oxygen Analyzers, A. O. Beckman 89
Refractometer, Conimeter, Gamma-B 94
Specific-gravity Meters Ohmart 110
Gas Analysis, Bailey Meter 119
Gas Analyzers, pH, Cambridge 125
Gas Analyzer, Gow-Mac 136
Laboratory Stirrer, Heller 137
Synchro-Lectric Viscometer, Brookfield 161
Golay Infrared Detector, Eppley 196

OPTICAL

Photographic Lenses, Equip., B & James 68
Optical Coatings, Components, Pacific 88
Photoelectric Meters, Gamma-B 94
Optical Components, Instruments, Unertl 159
Projectors, Microscopes, Nife 169

TIME, SPEED, FREQUENCY

Electronic Tachometer, Standard Elec. 32
Frequency Standards, American Time 38
Program Timer, General Controls 49
Timing Motors, Devices, Haydon 73
Time, Frequency Counter, Potter 75
Digital Counter, Printer, Berkeley 98
Timers, Alma 109
Motor Speed Control, Servospeed 117
Timers, Time Totalizers, Cramer 143
Timers, Controllers, Eagle Signal 171
Tachometers, Phase Indicators, Ass. Res. 191

COMPUTING, COUNTING

Analog Computer Service, Askania 13
Computer Circuit Elements, Burroughs 21
Counter-computer, Veeder-Root 26
Digital Counter, Computer, Beckman.... 29
Network Analyzers, Standard Electric 32
Computers, Integrator, Librascope 50
Microsyn Computer Element, Doelcam 61
Milac Analog Computers, Miller 66
Analog Data Recorder, Printer, S-Amet 148
Data Plotters, Reduction, B-Lehner 166

TEST CHAMBERS

Environmental Test Chambers, Webber 81
Environmental Test Chambers, Bowser 101
Climate-lab Test Chambers, Aminco 162

TESTING, INSPECTION

Scleroscope Hardness Tester, Shore..... 80
Mullen Burst Tester, Perkins 139
Vibration, Fatigue Tester, All American.. 141
Interferometers, Projectors, Nife 169
Hardness, Metal Testers, Pgh. Inst. 177
Granite Surface Plates, Collins 178
Test Turn Table, Genisco 197

RECORDING

Metagraphic Recorder, Bristol 16
Potentiometer Recorder, Thermo Electric 24
Tektolog Electronic Recorder, Fielden .. 30
Recording Oscillographs, Wm. Miller 66
Electrosensitive Recording Paper, Alfax 79
Magnetic Recording, Brush Electronics 84
Recording Oscillograph, Century Geo. 106
Recording Oscillograph, Hathaway 108
Chart Drives, Alina 109

ACCELERATION, VIBRATION

Linear Accelerometers, Statham Lab. 48
Gyro, Instrument Testers, Ideal 67
Stress, Strain, Vibration, Brush 84
Accelerometers, Gyros, Giannini 91
Vibration, Stress Systems, Century Geo. 106
Acceleration Indicator, Rutishauser 138
Vibration Tester, All American 141

ELECTRICAL, ELECTRONIC INSTRUMENTS

Signal Generator, Peak Voltmeters, Mc. Meters, Measurements Corp. 2
Test Instruments, Circuit Testers, Tube Analyzers, Inductronic Amplifier, Panel Meters, Weston 4
Ruggedized Panel Meters, DeJur-Amsco 11
Unitized Pulse Equipment, Burroughs..... 21
Frequency Standards, American Time 38
Microsyn Position Transmitter, Doelcam 61
Ultrasonic Equipment, Brush Electronics 84
Servo Analyzer, Boards, Servo Corp. 96
Instrument Electronics Book 105, 112
Ruggedized Panel Indicators, Burlington 115
Electric Panel Indicators, Triplett 122
Packaged Electronic Circuits, Walkirt 124
Test Instruments, Switches, United Optical 163
Electrostatic Voltmeters, Rawson 164
Electronic Test Instruments, Assoc. Res. 191
Oscillograph Galvanometers, Midwest Geo. 198

POWER SUPPLIES

Varicell DC Supply, Superior Electric 37
Regulated DC Supply, Inet 157
Nobatron DC Supply, Sorensen 183

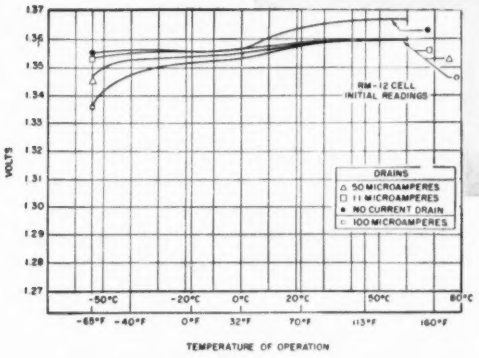
RELAYS, SWITCHES

Relays, Weston 4
5348 Relay Types, Struthers-Dunn 72
Time Delay Relays, Haydon 73
Relays, Open, Sealed, Auto-Electric 86
Relays, Precision, Advance Electric 90
Relays, Contactors, Automatic Switch 95
Stepping Switches, Automatic Electric 134
Plug-In Meter-Relay, Assembly Prod. 156

POTENTIOMETERS

Precision Potentiometers, DeJur-Amsco 11
Nonlinear Potentiometers, Beckman..... 29
Trimpot Potentiometer, Bourns Labs. 60
Potentiometer Transducers, Rahm 100
Ganged Potentiometers, Grayhill 126
10-turn Helipot, Helipot Corp. 135
Miniature Precision Pots, Electro-Mec 165

continued on page **1253**



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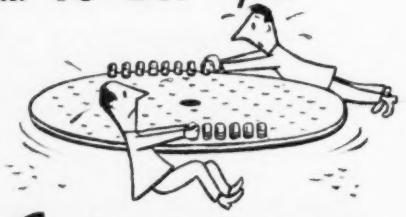

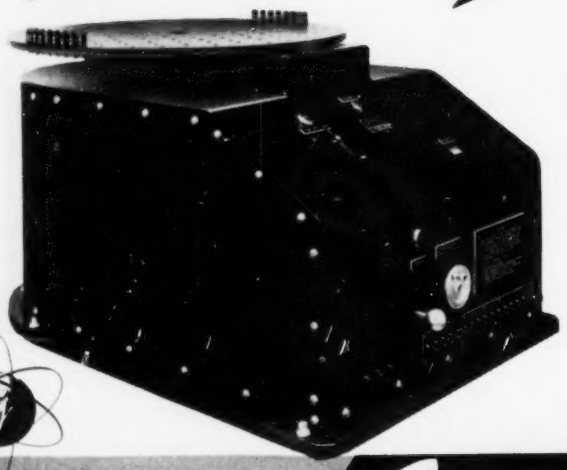

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CONNECTORS

Connectors, Plugs, Cannon Electric 7
Connectors, Cables, Wire, Amphenol 35
Unitized Connectors, Components, Alden 113

ELECTRONIC COMPONENTS

Magnetic C Cores, Arnold Eng. 17
Luminescent, Nonlum. Dials, U. S. Rad. 71
Thermistors, Bendix-Friez 118
Feed-through Terminals, Fusite 121
Miniature Pilot Lights, Dialco 149
Glass-metal Seal, Solder, Corro 160
Trimmer Capacitors, JFD Mfg. 168
Magnetic Materials, Laminations, T & S. 173
Electronic Supply Catalog, Allied 192
Mercury Batteries, Components, Mallory 195

AIR

Air Dryers, Filters, Lectrodryer 42
Dynamic Dehumidifiers, Industrol 102
Aridifier Filter, Dryer, Logan 104
Air Line Filter, Cuno Eng. 123
Air Filter, Dryer, Hankison 127
Air Cleaner, Dehydrator, Passaic 144
Dynamic Air Dryers, Kemp 152

VALVES

Diaphragm Motor Valves, Fisher Gov. 1
Diaphragm Motor Valves, K & Mueller 3
Safety Relief Valves, Farris 9
Diaphragm Control Valves, B S & Bryson 10
Small Reducing Valve, Leslie 25
Valves, General Controls 49
Control Valves, Annin 51
Series 700 Proportional Valve, M-Honeywell 55
Valves, O-Rings, Parker 62
Toggle Valves, Hoke 78
Valves, Relief, Balanced, Foster 85
Solenoid Valves, Automatic Switch 95
Butterfly, Slide Valves, W. S. Rockwell 97
Reducing Valves, Klipfel 145
Boiler Control Valves, Atlas 154
Diaphragm Control Valves, Hammel-Dahl 199

TUBING, FITTINGS

Precision Tubing, Superior Tube 41
Koncentrik Tube Fittings, Special Screw 52
Tube Fittings, Tools, Imperial Brass 59
Triple-Lok Tube Fittings, Parker 62
Corrosion-proof Tubing, Moore 70
Swagelok Tube Fittings, Crawford 74
Instrument Tubing Support, Instrof 175
Seamless Tubing, Uniform Tubes 194

PANELS, BOARDS

Instrument Panels, Boards, Felstorm 5
Process Control Panels, Panellit 15
Laboratory Panels, Standard Electric 32

SHOP EQUIPMENT

Pick-up Tweezer, Win Sales 63
Engravograph Engraver, New Hermes 64
Torque Wrenches, Sturtevant 69
Marking Machines, Acromark 82
Engraving, Etching, Marking, Preis 87
Soldering Irons, Elements, Hexacon 107
Hydraulic Presses, Wabash Metal 111
Engraver, Profiler, Green Instrument 128
Chemical Cleaner, Passaic Analytical 144
Micro-Drill Press, Levin 151
Engravers, Mico Instrument 158

MISCELLANEOUS

Miniature Precision Bearings, MPB 57
Chart Drives, Aline 109
Positions 77, 182, 184, 185, 186, 187, 188, 189
Instrument Repair, Sale, Florida 182

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Company _____
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Products Manufactured _____

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Company _____
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Products Manufactured _____

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ADVERTISERS' INDEX

Acragage Corporation 1238
Acromark Company 1154
Advance Electric and Relay Company 1160
Alden Products Co. 1176
Alfax Paper & Engineering Company 1152
Alina Corporation 1178
All American Tool & Machine Mfg. Co. 1171
Allied Radio Corp. 1248
American Balance Corp. 1240
American Chain & Cable Co. 1243
American Instrument Co., Inc. 1235
American Machine & Metals, Inc. 1093, 1111
American Meter Co. 1079
American Phenolic Corporation 1167
American Time Products, Inc. 1110
Amthor Testing Instrument Co. 1154
Annin Company 1125
Arnold Engineering Co. 1086
Askania Regulator Company 1080
Assembly Products, Inc. 1232
Associated Research, Inc. 1248
Atlas Valve Company 1229
Automatic Electric Mfg. Co. 1157
Automatic Electric Sales Corporation 1221
Automatic Switch Co. 1165

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Advertised Products									
1	21	41	61	81	101	121	141	161	181
2	22	42	62	82	102	122	142	162	182
3	23	43	63	83	103	123	143	163	183
4	24	44	64	84	104	124	144	164	184
5	25	45	65	85	105	125	145	165	185
6	26	46	66	86	106	126	146	166	186
7	27	47	67	87	107	127	147	167	187
8	28	48	68	88	108	128	148	168	188
9	29	49	69	89	109	129	149	169	189
10	30	50	70	90	110	130	150	170	190
11	31	51	71	91	111	131	151	171	191
12	32	52	72	92	112	132	152	172	192
13	33	53	73	93	113	133	153	173	193
14	34	54	74	94	114	134	154	174	194
15	35	55	75	95	115	135	155	175	195
16	36	56	76	96	116	136	156	176	196
17	37	57	77	97	117	137	157	177	197
18	38	58	78	98	118	138	158	178	198
19	39	59	79	99	119	139	159	179	199
20	40	60	80	100	120	140	160	180	

New Products									
201	221	241	261	281	301	321	341	361	381
202	222	242	262	282	302	322	342	362	382
203	223	243	263	283	303	323	343	363	383
204	224	244	264	284	304	324	344	364	384
205	225	245	265	285	305	325	345	365	385
206	226	246	266	286	306	326	346	366	386
207	227	247	267	287	307	327	347	367	387
208	228	248	268	288	308	328	348	368	388
209	229	249	269	289	309	329	349	369	389
210	230	250	270	290	310	330	350	370	390
211	231	251	271	291	311	331	351	371	391
212	232	252	272	292	312	332	352	372	392
213	233	253	273	293	313	333	353	373	393
214	234	254	274	294	314	334	354	374	394
215	235	255	275	295	315	335	355	375	395
216	236	256	276	296	316	336	356	376	396
217	237	257	277	297	317	337	357	377	397
218	238	258	278	298	318	338	358	378	398
219	239	259	279	299	319	339	359	379	399
220	240	260	280	300	320	340	360	380	400

New Literature									
401	421	441	461	481	501	521	541		
402	422	442	462	482	502	522	542		
403	423	443	463	483	503	523	543		
404	424	444	464	484	504	524	544		
405	425	445	465	485	505	525	545		
407	427	447	467	487	507	527	547		
408	428	448	468	488	508	528	548		
409	429	449	469	489	509	529	549		
410	430	450	470	490	510	530	550		
411	431	451	471	491	511	531	551		
412	432	452	472	492	512	532	552		
413	433	453	473	493	513	533	553		
414	434	454	474	494	514	534			
415	435	455	475	495	515	535			
416	436	456	476	496	516	536			
417	437	457	477	497	517	537			
418	438	458	478	498	518	538			
419	439	459	479	499	519	539			
420	440	460	480	500	520	540			

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ADVERTISERS' INDEX

Continued from page 1253

Bailey Meter Co. 1109
Baldwin-Lima-Hamilton Corp. 1186
Barksdale Valves 1199
Barton Instrument Corp. 1247
Beckman, Inc., Arnold O. 1159
Beckman Instruments, Inc. 1160
Bendix Aviation Corp. 1177
Benson-Lehner Corporation 1237
Berkeley Scientific Div., Beckman Instruments, Inc. 1167
Black, Sivalls & Bryson, Inc. 1077
Bourns Laboratories 1134
Brewer, Inc. 1169
Brinkmann & Company, C. A. 1164
Bristol Company 1084-1085, 1232
Brookfield Engineering Laboratories, Inc. 1235
Brown Instrument Division, Minneapolis-Honeywell Regulator Co. 1246
Brush Electronics Company 1085
Burke & James, Inc. 1142
Burling Instrument Co. 1223
Burlington Instrument Co. 1176
Burroughs, Electronic Instrument Div. 1071

Cambridge Instrument Co., Inc. 1217
Cannon Electric Co. 1074
Century Geophysical Corp. 1171
Cerro de Pasco Corp. 1225
Chace Co., W. M. 1149
Collins Microflex Co. 1242
Colvin Laboratories 1219
Consolidated Engineering Corp. 1075
Cramer Co., Inc., R. W. 1226
Crawford Fitting Co. 1147
Cuno Engineering Corporation 1216
Daniel Orifice Fitting Co. 1243
Davis Instruments, Div. of Davis Emergency Equipment Co., Inc. 1117
De Jur Amsco Corporation 1078
Dialight Corporation 1227
Doelcam Corporation 1126
Eagle Signal Corporation 1239
Edison, Inc., Thomas A. 1121
Electric Auto-Lite Co. 1176
Electro-Mec Laboratory 1236
Eppley Laboratory, Inc. 1252
Fairchild Engine & Airplane Corp. 1190
Falstrom Company 1072
Ferris Engineering Corp. 1076
Fielden Instrument Division 1101
Fisher Governor Co. ..... Inside Front Cover
Florida Precision Instrument Company 1244
Foster Engineering Company 1166
Foxboro Company 1077, 1228
Friez Instrument Div., Bendix 1177
Fulton-Sylphon Division 1087
Fusite Corporation 1214
General Controls Co. 1125
Genisco Incorporated 1252
Giannini & Co., Inc., G. M. 1161
Gordon Co., Claud S. 1132
Gotham Instruments, Div. of American Machine & Metals, Inc. 1111
Gow-Mac Instrument Co. 1222
Grayhill 1218
Green Instrument Co. 1219
Hagan Corporation 1108
Hammel-Dahl Co. ..... Back Cover
Hankison Corporation 1218
Hathaway Instrument Company 1172
Haydon Mfg. Co., Inc. 1146
Heise Bourdon Tube Co. 1244
Helicoid Gage Div. 1240
Helipot Division, Beckman Instruments, Inc. 1222
Heller Company, Gerald K. 1223
Hetherington & Berner, Inc. 1237
Hewlett Electric Co. 1172
Hoke Incorporated 1161
Ideal Laboratory Tool & Supply Co. 1141
Illinois Testing Laboratories, Inc. 1238
Imperial Brass Mfg. Co. 1133
Industrial Div., Minneapolis-Honeywell Regulator Co. 1129, 1162-1163
Industrial Pyrometer & Supply Co. 1108
Industrol Corp. 1170
Inet Inc. 1234
Instrof Incorporated 1241
Instrument & Control Consultants 1235
JFD Mfg. Co. 1238
Johnson-Williams, Ltd. 1130
Kern Chemical Equipment Company 1164
Kemp Mfg. Co., C. M. 1227
Kieley & Mueller, Inc. 1070
Kilpfel Valves, Inc. 1226
Lapp Insulator Co., Inc. 1072
Leeds & Northrup Co. 1118, 1190
Leslie Co. 1095
Levin & Son, Inc., Louis 1238
Lewis Engineering Co. 1073
Librascope, Inc. 1124
Logan Engineering Co. 1171
Mallory & Co., Inc., P. R. 1251
Manning, Maxwell & Moore, Inc. 1112
Marsh Instrument Co. 1221
Marshalltown Mfg. Co. 1235
Mason-Neilan Regulator Co. 1098-1099
Measurements Corp. 1069
Meriam Instrument Co. 1219
Mico Instrument Co. 1236
Midwestern Geophysical Laboratory ..... Inside Back Cover
Miller Instruments, Inc., William 1140
Miniature Precision Bearings, Inc. 1131
Minneapolis-Honeywell Regulator Co. 1129, 1163-1163, 1246
Moeller Instrument Co. 1224
Monsell, John R. 1170
Moore & Company, Samuel 1143
Nash Engineering Company 1116
New Hermes, Inc. 1138
Nifo Incorporated 1238
Ohmart Corporation 1174
Pacific Universal Products Corporation 1169
Palmer Thermometers, Inc. 1128
Panellit, Inc. 1082-1083
Parker Appliance Company 1086, 1127
Passaic Analytical Laboratories, Inc. 1225
Perkins & Son, Inc., B. F. 1223
Pittsburgh Instrument & Machine Co. 1242
Pittsburgh Lectrodryer Corporation 1114
Potter Instrument Company 1140
Preis Engraving Machine Co., H. P. 1188
Pyrometer Service Co. 1090
Rahm Instruments, Inc. 1168
Rawson Electrical Instrument Co. 1236
Republic Flow Meters Co. 1102-1103
Revere Corporation of America 1115
Richards Co., Inc., Arklay S. 1248
Rochester Mfg. Co., Inc. 1175
Rockwell Co., W. S. 1166
Rotishauser Corp. 1228
Servo Corporation of America 1166
Servospeed Division of Electro Devices, Inc. 1177
Shore Instrument & Mfg. Co. 1163
Sorensen and Company, Inc. 1245
Special Screw Products Co. 1126
Standard Electric Time Co. 1104
Statham Laboratories 1122
Streator-Amet Co. 1227
Struthers-Dunn, Inc. 1145
Sturtevant Co., P. A. 1142
Superior Electric Co. 1109
Superior Tube Company 1113
Swartwout Company 1231
Swissomatic Products 1246
Taylor Instrument Companies 1088-1089
Tennessee Valley Authority 1246
Thermo Electric Co., Inc. 1094
Thomas & Skinner Steel Products Co. 1240
Transistron Co. 1240
Trimount Instrument Company 1229
Trinity Equipment Corp. 1168
Triplett Electrical Instrument Co. 1215
Uehling Instrument Co. 1244
Unertl Optical Co., John 1234
Uniform Tubes 1249
United Optical Manufacturing Corp. 1236
United States Gauge, Div. of American Machine & Metals, Inc. 1093
United States Radium Corp. 1144
Veeder-Root Inc. 1096
Wabash Metal Products Co. 1174
Walkirt Co. 1217
Wallace & Tiernan Products, Inc. 1081, 1227
Webber Manufacturing Company, Inc. 1183
Weston Electrical Instrument Corp. 1071
Wheelco Instruments Division, Barber-Colman Company 1127
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Midwestern's new Model 158 top-adjusting, positive-locking magnetic structure assures accurate independent adjustment of each galvanometer in both horizontal and vertical directions. The plug-in type galvanometers are mechanically locked in a firm vibration-proof grip and are electrically insulated from the magnetic assembly. The new silver-plated dual-contact design makes a positive low-resistance connection to each galvanometer. The galvanometers are spaced on .144 inch centers which provides ample clearance to prevent shorting between adjacent elements.

Our Model 102 and 106 galvanometers are small, precision-built and rugged. This is a direct result of years of research and development guided by long end-use experience in the galvanometer application field. These instruments are hermetically sealed and have negligible zero-position drift when they are subjected to wide temperature variations. This is due to the unique suspension design which allows the suspension to be without twist at mid-position.

Dummy galvanometers are available which have the same magnetic reluctance as the actual galvanometers and are furnished with or without mirrors; the former are used to produce reference traces on the record in addition to maintaining proper magnetic-structure flux distribution.

★ **SPECIFICATIONS . . .**

Model 158
MAGNETIC STRUCTURE

FLUX: When the flux is measured with a standard galvanometer it will not vary more than 2% between corresponding holes in any similar magnetic structure, and 2½% between any two holes in the same magnetic structure.

ADJUSTMENT: Both horizontal and vertical adjustments are made from the top of the structure.

Maximum vertical galvanometer adjustment with positive mechanical stop ..... ±6°

Maximum allowable horizontal galvanometer adjustment for constant flux density ..... ±11°

(Galvanometers may be continuously rotated in either direction without damage.)

Models 102 and 106 GALVANOMETERS

★ **SPECIFICATIONS . . .**

GALVANOMETERS

Normal balance of the Model 102 galvanometer is .030 in./g of lateral acceleration; special balance of .008 in./g is available at extra cost. Normal balance of the Model 106 Galvanometer is .004 in./g of lateral acceleration. The above displacements are measured at 12 in. optical arm. The mirrors are prefocused plano-cylindrical for use in Midwestern oscillographs or custom mirrors of 2½ in. to 17 in. focal length.

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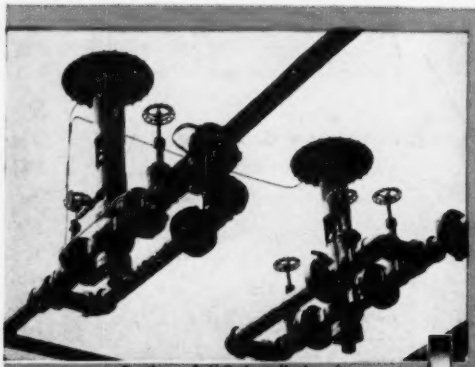
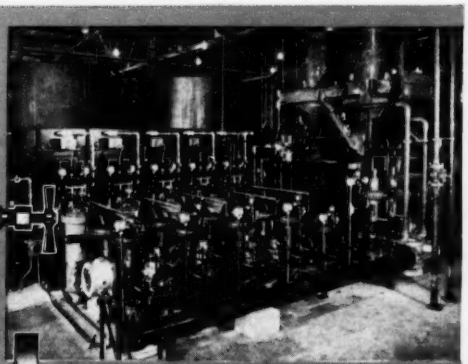
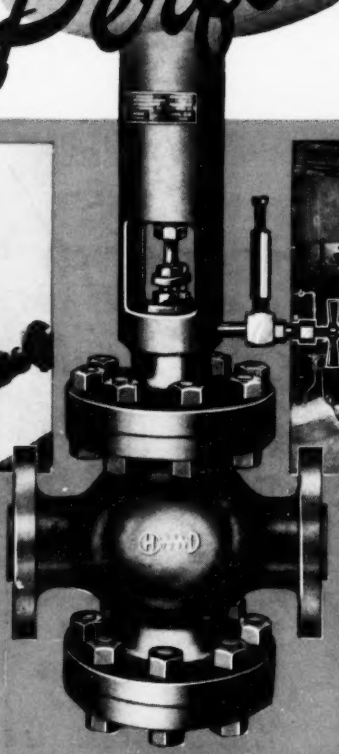


Portion of H-D installation in a Pennsylvania chemical plant.



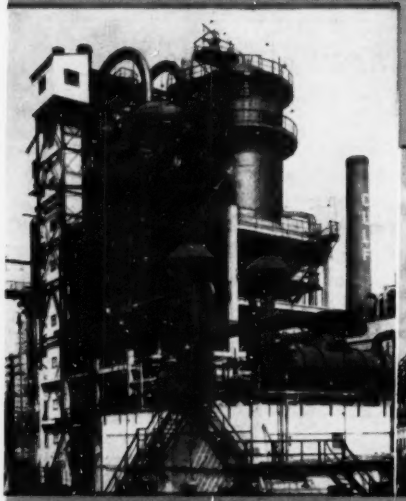
Sun Oil Company's Blending Process controlled by a battery of H-D Valves.

HAMMEL-DAHL CONTROL VALVES

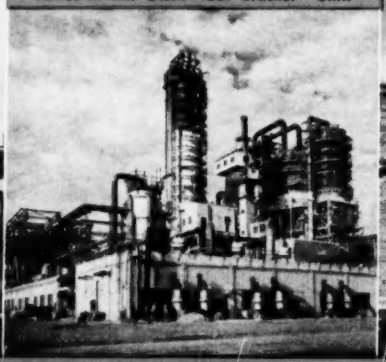


Gulf Oil Corporation uses H-D Control Valves in this Refinery.

Lever Bros., Solexol Unit served by H-D Control Valves.



The Texas Company installed H-D Control Valves in this Giant "Cat Cracker" Unit.



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